Second Tooling Equipment Number

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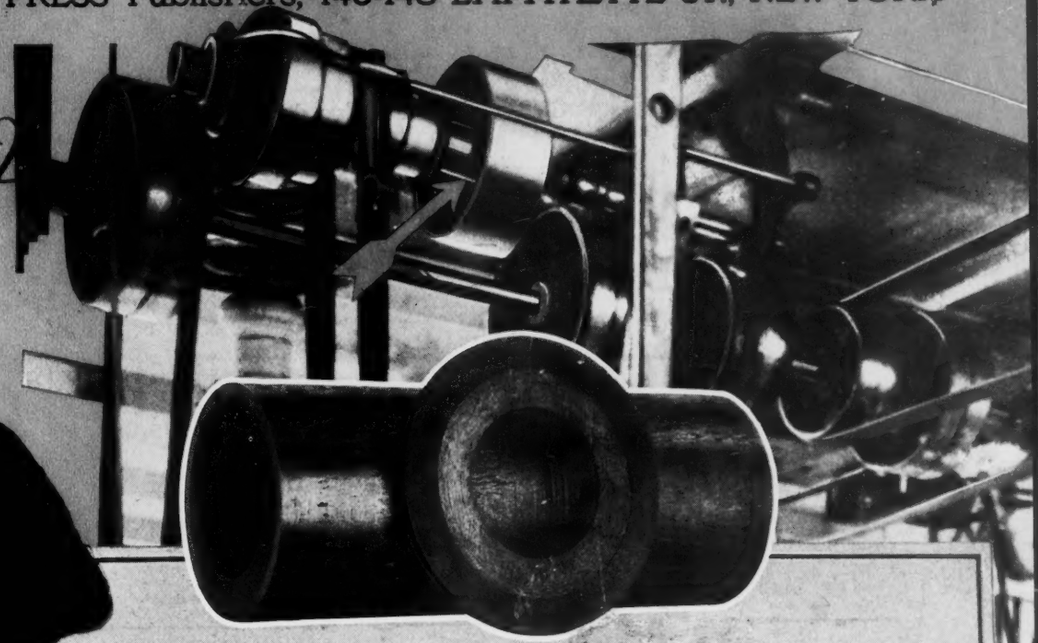

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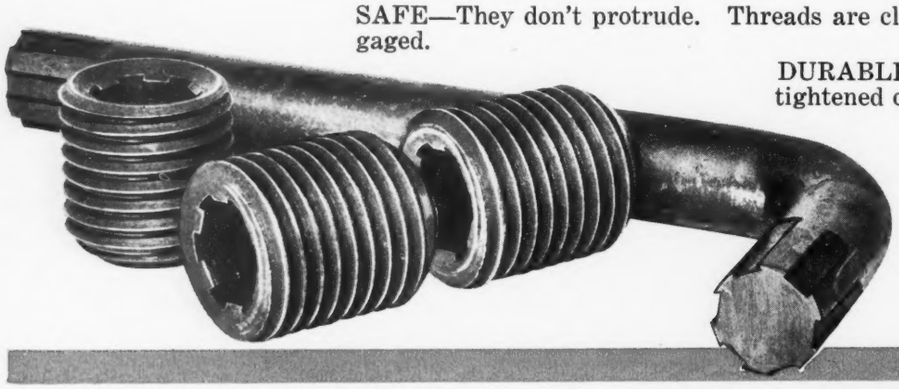

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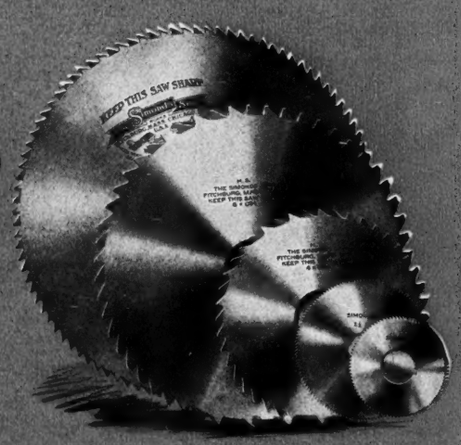

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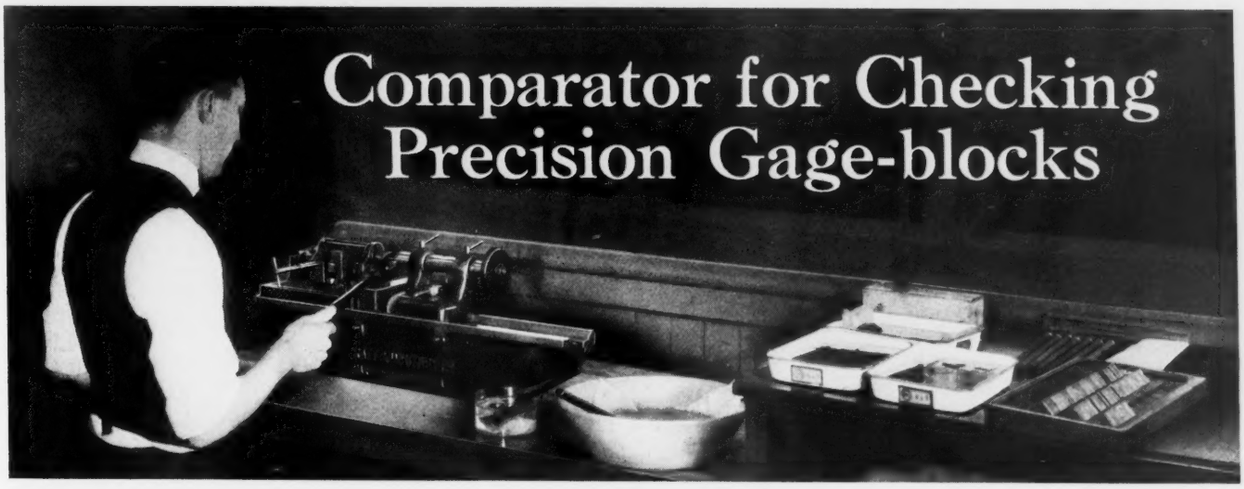
Comparator for Checking Precision Gage-blocks



An Extremely Sensitive Mechanical Apparatus, which has Proved Very Effective at the Plant of the Pratt & Whitney Co., for Testing the Accuracy of Precision Gage-blocks

By FRANKLIN D. JONES

CHECKING the sizes of precision gage-blocks in connection with their manufacture must necessarily be by comparison with a master block or standard of known accuracy, because a comparative test can be made quickly and is entirely reliable when all necessary precautions are taken. At the plant of the Pratt & Whitney Co., Hartford, Conn., the accuracy of the precision gage-blocks manufactured and of the working and primary standards is maintained by three different methods of testing, which are so related as to insure a uniform degree of precision, approaching very close to absolute perfection.

First, there is the well-known optical test employed to check the sizes in connection with the mechanical lapping of the commercial gage-blocks. This simple test, which requires the use of optical flats, or exceedingly accurate glass planes, has already been described in MACHINERY, and will not be considered further (see April, 1920, MACHINERY, page 705). This optical test, which is relatively accurate and quickly made, serves to compare the commercial gage-block with a working master.

The optical test has these disadvantages: (1) Its accuracy is plus or minus three-millionths inch, and a whole interferometer band may easily be missed, introducing an additional error of ten-millionths inch. (2) The gage-blocks must be handled in wringing, so that the operator may not have the block at temperature when the reading is taken. (3) It is an optical and not a contact measurement, and the condition of the block surface as regards polish may give an incorrect reading. This reading will be correct optically for the block, and yet it will not be correct for its contact value when the gage is placed in a stack with other blocks.

To safeguard against the probabilities referred to, a "millionth comparator" is used to check against masters. This comparator has no intrinsic temperature or band errors. The masters are not checked in the comparator except when a block gives two plausible readings in the interferometer described later. Then the masters are stacked against others which have given no trouble, and one of the two readings is selected, which checks with the observation in the comparator. The comparator is used to check every commercial block which will pass the optical test. This check can be further augmented by a test made at the Bureau of Standards, if it is desired.

Making precision gage-blocks on a commercial basis requires an extremely accurate, dependable, and fairly rapid method of checking the truth of gage surfaces and their dimensions. The "millionth comparator" here described meets these exacting requirements by providing a mechanical test, which follows the well-known optical test and serves as an additional safeguard against errors. The master gages or primary standards used for this comparative test, are measured by means of an interferometer in which light waves are utilized as the ultimate standard either for originating or checking dimensions with the greatest possible degree of accuracy.

Measurement of the Primary Standards

Now all blocks tested by the comparator are compared directly with primary standards, measured by the most precise method known. A bare outline of this method, which is too complex to be described fully here, will be given before considering the comparator.

While master gages or standards for checking other gages by direct comparison may also have been subjected to some purely comparative test, it is evident that there must be a fundamental method of measuring the primary standard. There is no intermediate master between the super-master and the commercial block. Every batch of blocks made is measured against a master which has been read in the interferometer just previous to the beginning of the job; thus a master may be read many times in its life. Such refinement is unnecessary in most

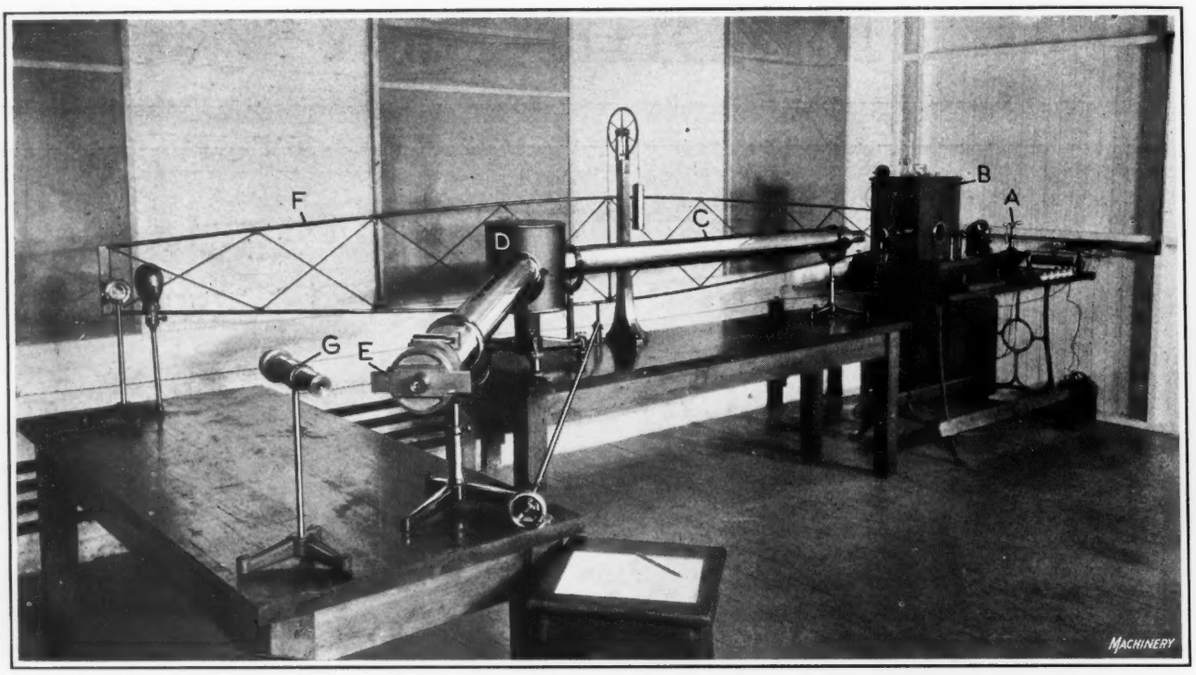


Fig. 1. Fabry & Perot Interferometer used by the Pratt & Whitney Co., for calibrating or measuring Primary Standards

cases, since successive readings check, but it is worth while because the method is absolutely safe. When one of these primary standards requires measuring either to determine the dimension of a new one or to check the size of an old one, this fundamental measurement is made by the interferometer. The use of this optical apparatus is a scientific undertaking, requiring considerable time and involving complex calculations. For this reason all commercial methods of checking accuracy must be comparative, and the taking of fundamental measurements is necessarily confined to the basic or primary standards, such as are used to a very limited extent for checking working masters, where the greatest possible degree of accuracy is required.

Use of the Interferometer

The interferometer used by the Pratt & Whitney Co. is shown in Figs. 1 and 2. This apparatus, which is one of the few in existence, is used to assist in determining the number of light waves of known wave length (or color) which at a given instant are between two planes coinciding with the opposite faces of a gage-block or whatever part is to be measured. When this number is known, the thickness can be computed because the lengths of the light waves used have been determined with almost absolute precision. The light, therefore, becomes a scale with divisions—approximately two hundred-thousandths inch apart.

The block to be measured is placed between two glass planes of great accuracy, which have previously been wrung into perfect contact, so that each plane extends beyond the block on one side. Thus the block is measured optically by contact and not by reflection from the gage surface itself. The character of the surface is likely to affect the latter reading, and the degree of polish cannot affect the first method, since the light does not strike the surface. The projecting ends of the glass planes are covered by an exceedingly thin transparent film of gold about one-half millionth inch thick, to increase the reflecting power. The planes with the block between them are secured to a suitable holder, which

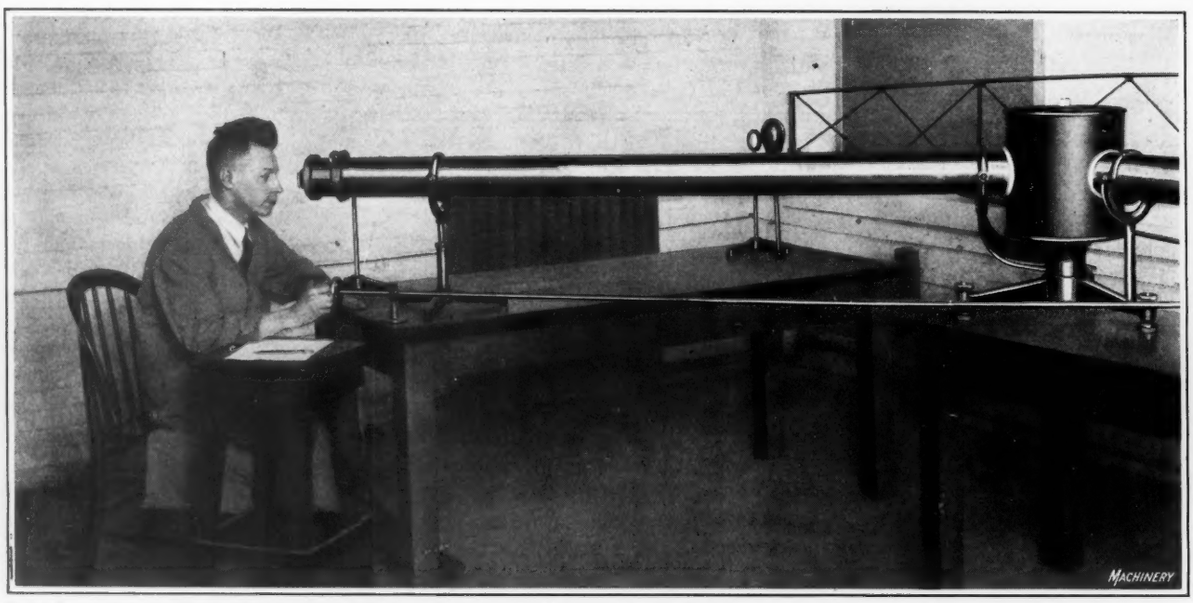


Fig. 2. Taking a Reading with the Interferometer which makes it Possible to use Light as a Scale, with Divisions approximately Two Hundred-thousandths Inch Apart, for measuring Reference Standards

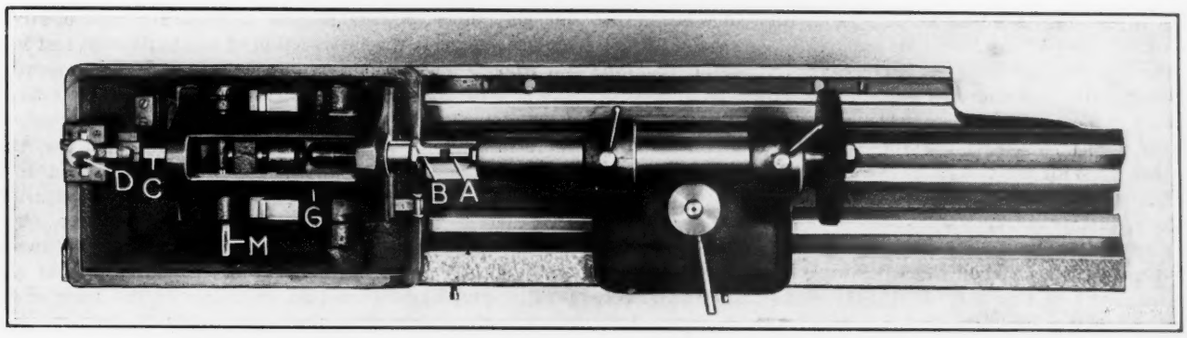


Fig. 3. Plan View of Comparator used for checking Precision Gage-blocks

is inserted in box *B*, Fig. 1, through an opening in the side. A constant temperature is maintained inside of this box by circulating oil through a series of coils and by means of a thermostat in conjunction with an electrical heating unit which serves automatically to maintain the temperature within very close limits.

The standard wave lengths used are those emitted by glowing Neon gas under electric discharge. These wave lengths have been calibrated against the Michelson-Benoit standard by Meggers and Peters of the Bureau of Standards to an accuracy of one part in four millions. It has been found to be a satisfactory and constant reference standard under easily reproducible physical conditions. The Neon light is located at *A*. Light waves from this source enter through a lens and suitable opening into box *B*, pass through the projecting ends of the glass planes referred to, and then through another lens and tube *C* to a prism or spectroscope located within the cylindrical box *D*. The light is refracted, and the rays of different lengths separated by this prism so that they can be observed through the telescope at *E*. The holder carrying the glass planes and block to be measured is attached to and turns with a long protractor arm *F* of light tubular construction. At the outer end of this arm there is a scale indicating angular movements, and this is enlarged by the telescope *G* at the observing end of the apparatus. The angular position of the protractor arm and of the glass planes is regulated by turning a handwheel (see Fig. 2) which transmits motion to the arm through suitable shafting and gearing.

Now at certain angular positions of the glass planes the phenomenon of light interference occurs. These angles, which vary for different light rays, are noted by taking readings on the scale seen through telescope *G*. When several of these angular values are known, in addition to the lengths of the different light waves, the required distance between the two planes is determined mathematically by a process of elimination carried on until the true value is obtained, as proved by the fact that it is the only value that satisfies an equation containing the other known values. When the number of waves is found (within a small fraction of a wave) it is multiplied by the known wave length, and the product is the absolute length of the block. This gage is now a master, or primary standard, and may be confidently used to calibrate commercial gage-blocks.

Before a measurement can be taken, the block must be left in box *B* until it has acquired the same temperature. Also, considerable time is needed for the various adjustments, readings, and calculations, so that the measurement of four blocks would require ordinarily an entire day. The extreme degree of precision which it is possible to attain by the interferometer method is indicated by the fact that measurements by Mr. Mueller of the Pratt & Whitney Co., have checked within one-millionth inch with measurements of the same gage-blocks made by Mr. Peters at the Bureau of Standards, each measurement being made independently on different types of interferometers.

General Arrangement of Comparator and Method of Using

When the comparator is used to compare the accuracy of a gage-block with a primary standard, the latter is first placed between the parallel surfaces of the fixed anvil *A*, Figs. 3 and 4, and the movable anvil *B*. The apparatus is then adjusted until a zero reading is obtained. The block to be checked is next placed between the gaging ends and any difference in reading is noted. The slightest change in the position of the movable spindle is transmitted through the multiplying lever *C* to a small and slightly concave mirror *D*. When this mirror is tilted, a V-shaped shadow obtained from light *E*, Fig. 5, which passes through a lens at *H* partly obstructed by a V-shaped projection, is reflected from *D* (Fig. 4) up to mirror *F* and then down to a scale located on the wooden case which encloses the comparator as shown in Fig. 6. The slightest movement of mirror *D* causes the image of the V-shaped projection to move rela-

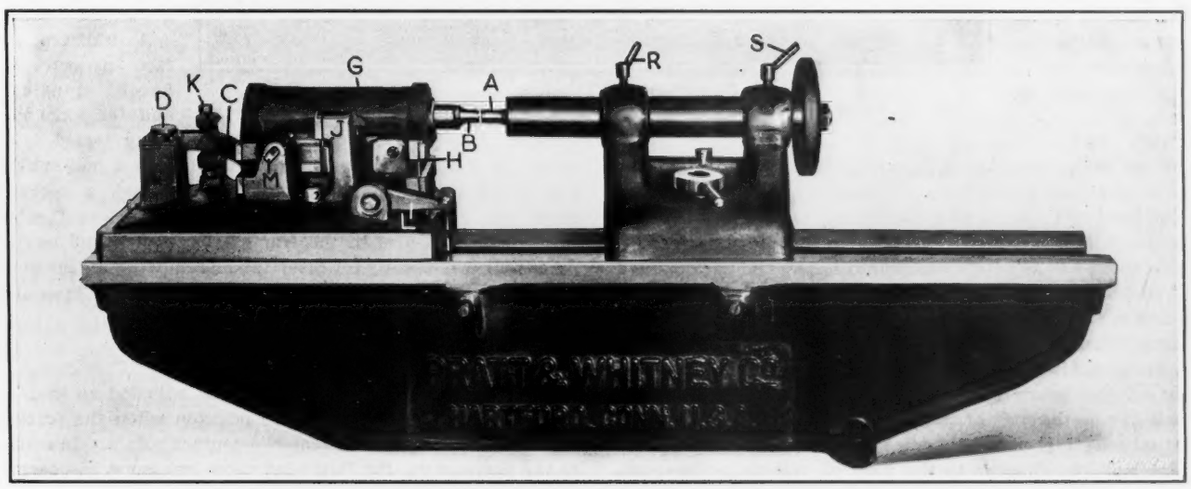


Fig. 4. Side View of Comparator which by using a Light Beam as a Lever multiplies the Movements of its Anvil 20,000 Times

tive to the zero position on the scale, thus indicating the error.

The comparator is so sensitive that a variation of even one-millionth inch causes a perceptible movement of the reflected shadow, and this sensitiveness can be increased readily by simply elevating the upper reflecting mirror and refocusing. With the two mirrors 2½ meters apart, the movements of the gaging anvil are multiplied 20,000 times, and because of this extreme sensitiveness the mechanical part of the apparatus must be enclosed when in use, since the temperature of the body causes changes that interfere with the accuracy of the test. While this comparator was built by the Pratt & Whitney Co., it is based upon a design furnished by the National Physical Laboratory of England and is one more indication of the value of this scientific organization which, like our own Bureau of Standards, has contributed so much toward scientific research and the development of apparatus for industrial uses.

One of the remarkable features of the comparator is its "dead-beat" action. There are no perceptible oscillations of the indicating shadow relative to the scale, or movements which must be allowed to die out before a reading can be taken. If the shadow is suddenly deflected from the zero position, as by lightly striking the table supporting the mechanism, the movement back to the zero point is instantaneous and without repeated vibrations. This dead-beat quality is due to the unusual method of providing for the necessary movements of the spindle frame and multiplying lever, without introducing the slightest radial or other play, such as would occur in some degree in any ordinary form of bearing.

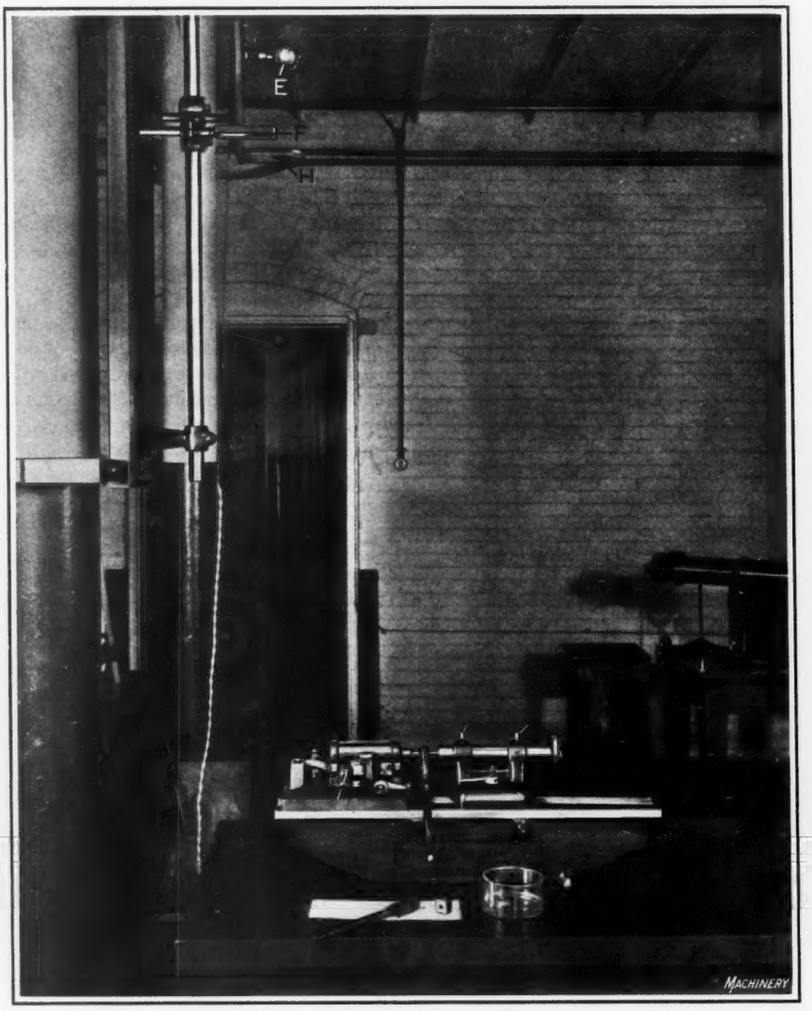


Fig. 5. Comparator with Upper Light and Mirror which reflects a Shadow upon a Scale indicating the Error

The head or frame *G* (see Figs. 3 and 4) carrying the movable anvil is supported at each end by steel ribbons or thin plates about 0.003 inch thick. There is one ribbon *H* extending across the front, and two ribbons at the opposite end with a space between, through which multiplying lever *C* passes. These ribbons allow a slight lengthwise movement, but anvil *B* always occupies parallel positions. Any movement of the frame carrying *B* is transmitted to lever *C*, which has as the axis of its fulcrum the intersection of vertical ribbons *J* (located at each side of the lever) with horizontal ribbons adjacent to the vertical ribbons. These ribbons, which are about 0.004 inch thick, provide an exceedingly accurate fulcrum, and eliminate all radial, lateral, or angular play, because they form a cross and permit a turning movement about the intersection of the horizontal and vertical ribbons, but are sufficiently rigid to resist any movement except a turning of lever C about this axis of intersection.

This multiplying lever *C* is carefully counterbalanced, and there is a point of contact between the lever and the frame through a ball located in a pocket at the upper end of the lever. The ball bears against the flat end of an adjustable plug carried by frame *G*. On the mirror end of lever *C* there are two small and very accurate plugs placed parallel to each other with a small space between. Similar pairs of fixed parallel plugs are located on each side of the lever and at right angles to those on the lever itself. These three pairs of plugs form the bearing surfaces for three very small balls which are attached to the under side of the reflecting mirror *D*. One ball which rests on the plugs at the end of the lever is offset relative to the other two balls, so that a 10 to 1 leverage back to this point is increased 2000 to 1, as the shadow is reflected to the upper mirror and back to the scale. The lens and circular opening, which is partly obstructed by the V-shaped projection, forms a shadow in such a way that the scale where the readings are taken is illuminated so that any movement of the shadow is readily seen. This scale has plus and minus graduations on each side of the zero position, with graduations indicating five-millionths inch and spaces between them which are sufficiently large to enable millionths of an inch to be estimated readily.

A uniform contact pressure between spindle *B* and the gage-block being tested is obtained by means of a weight suspended from a bellcrank *L*, Fig. 4, which connects with frame *G* through a spherical ended pin, resting in V-shaped pockets formed in the bellcrank lever and also in the frame. The frame and anvil *B* are withdrawn slightly for inserting or removing a gage-block, by turning shaft *M* which has eccentric surfaces in contact with the frame.

Adjusting and Using the Comparator

Before the comparator is used, it is adjusted so that the indicating shadow is in the zero position when the primary standard to be used is between the contact points. In setting up the comparator, the following procedure must be observed strictly or imperfect readings will result.

A weight attached to the bellcrank *L* is removed so that

the recording anvil and its carriage assume an unstrained position. The tilting mirror and lever *C* are adjusted so that the mirror *D* is approximately horizontal. The remainder of the optical system is then adjusted until the image falls on the center of the scale and is in focus. A small block on the anvil carriage is now brought up against the ball on lever *C* until it is just in contact. This will insure that when the indicating shadow is on the scale, the two parallel springs supporting the anvil carriage and the cross-springs on lever *C* are all in mid position and unstrained. It is essential also that the machine be built with sufficient accuracy so that, in clamping the battens that bind down these springs, no warp or twist will be introduced into the springs which will not come out by taking off the bellcrank weight. The bellcrank weight is now replaced, which pulls the anvil into a strained position and tilts the mirror forward. Now the anvil may be retracted by the eccentric cams on the operating shaft *M*.

The whole purpose of this proceeding is simply to get the flexible springs in an unstrained condition near the point of measurement. From now on when successive blocks are placed between anvils for measurement, we can be sure that if the light remains on the scale, these springs have not been flexed a sufficient amount beyond their neutral position to affect the accuracy of the measurement.

The fixed anvil *A* is adjusted so that the space between the two contact points is slightly less than the width of the block to be checked. A primary standard is then placed between the contact surfaces, anvil *B* being withdrawn by turning eccentric or camshaft *M*. The spindle holding anvil *A* has a very accurate wringing fit in its two bearings and is next moved forward by simply turning and pushing it along until the indicating shadow is in the zero position. As a movement of a few millionths inch will cause a decided movement of the shadow, it is evident that a very sensitive adjustment for anvil *A* is necessary, and the degree of sensitiveness obtained simply by turning and at the same time gently pushing the spindle is an interesting feature of this part of the construction.

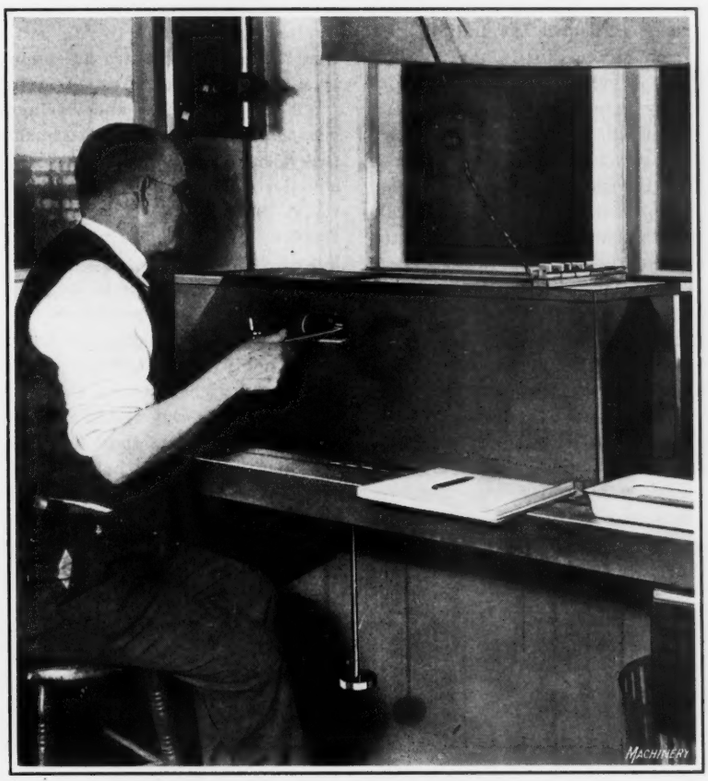


Fig. 6. View showing Case in which Comparator is enclosed when in Use to prevent Errors due to Temperature of the Observer's Body

When the shadow is at the zero position, the spindle holding anvil *A* is locked by two screws *R* and *S*, which act against bronze shoes bearing on the top of the spindle. The apparatus is so sensitive that clamping one of these screws even lightly deflects the shadow from the zero position decidedly, but it may be brought back readily by first tightening one screw and then the other until their effect on the spindle is neutralized. The rear anvil is lapped square with its axis in the bar and the sensitive anvil is then finished as nearly parallel as possible with the rear anvil when neither of the binding screws is tightened. When setting up for a block, the rear anvil is brought up against the block resting on the sensitive anvil, and since neither of the binding screws is down, it can be assumed that the two anvils are as parallel as when they were lapped. When one binding screw is put down, the flexure out of parallelism of the two faces is immediately made known by the movement of the indicating shadow. If this is brought back to its original position by tightening the other screw, it can be assumed that the anvils have again been brought parallel. This process is repeated alternately on each of the screws until they have both become tight.

It has been found that gage-blocks having dry surfaces cannot be tested satisfactorily because of minute dust particles which adhere to the surfaces and affect the reliability of the readings. This difficulty was overcome by a very simple method. The surfaces of the primary standards and the gage-blocks to be compared with them are first cleaned chemically by using ether; then, all of the blocks are immersed in highly refined and filtered kerosene mixed with a small amount of sperm oil, so that the surfaces are covered by an oil film when they are placed between the anvils of the comparator.

The block to be tested is held by pincers made of a non-conducting material (see Fig. 5), since the temperature of the hands would make it impossible to obtain accurate tests. When the block is first placed between the anvils, the end of the holder is moved up and down and tapped lightly, thus turning the block somewhat. This is necessary in order to reduce the oil film to a final thickness. This reduction, which is a very interesting phenomenon, is indicated by decided jumps in the position of the shadow relative to the scale. When the shadow settles to a point where there is no further movement as a result of the tapping on the holder, the very slight oil film remaining can be relied upon, as it is absolutely uniform for a given oil, as far as can be determined by repeated tests. To safeguard against any changes in the zero position, the primary standard is frequently inserted, assuming that a number of other standards or gage-blocks are being compared with it. This comparator has proved to be of great value, as it provides an exceedingly accurate, dependable, and comparatively rapid method of checking the accuracy of precision gage-blocks.

* * *

The Bureau of Standards has recently conducted an investigation of the operation, efficiency, and safety of oxy-acetylene welding and cutting blow-pipes. Apparatus from fourteen different makers was submitted to tests, developed jointly by the bureau in cooperation with makers. The blow-pipes were tested in a standard manner to minimize the personal equation. It developed that the principles upon which the design of such blow-pipes should be based were not well understood, and the conclusions reached should be useful to the industry. The results of the tests have been published in Technologic Paper No. 200 of the Bureau of Standards.

A Shuttle-type Drill Jig

A DRILL jig of unusual and interesting design is used for boring and drilling holes in rotary pump cases and covers in the plant of the Goulds Mfg. Co., Seneca Falls, N. Y. The jig is of a shuttle type. The chucking carriages or shuttles are started at one end of a box and pass the work through to successive spindle centers for machining, until they emerge at the opposite end with the work finished. This long shuttle box is fastened to the table of a four-spindle Barnes multiple drilling machine, as illustrated in Fig. 1. A track is provided for the shuttles, on which they slide as they are advanced from station to station.

Three views of the shuttle are shown in Fig. 2, as well as detailed views of the pump case. The shuttle is made of cast iron, open at the ends, and has a steel rack attached to the bottom so that it may be advanced by pinions, operated by handwheels at the front of the shuttle box. A sufficient number of these shuttles is provided so that the four spindles can be kept constantly in operation, and an extra shuttle permits work to be loaded in readiness to be advanced into the first spindle position as soon as this is free. The pump cases are loaded in the shuttles on a bench, and are located by four 5/16-inch pins in the top plate, as indicated in Fig. 2. They are then secured against the top plate by four jack-screws carried in bosses in the baseplate of the shuttle. Two steel-bushed tapered index-holes are located to correspond with the pitch centers of the rotary pump gears, so that by the use of a spring index-pin at the front of the shuttle box opposite each spindle, the shuttle may be correctly located while the two holes in the casting are machined. The same type of jig is used for machining the covers, the holes in which must correspond and align with those in the case, the only difference being that longer jack-screws are used.

When the loaded shuttle is placed on the extending track at the left-hand end of the shuttle box, the rack on the under side is engaged by the pinion on the first handwheel and the shuttle is advanced until the index-pin engages the first bushed hole in the shuttle box. At this station a four-lipped combination drill and countersink is employed to rough-bore one of the 1 1/16-inch holes and relieve the edge of the hole slightly with the countersink. The index-pin is then removed and the shuttle advanced to the second hole, where the operation is repeated. The work on each spindle is so timed that there is no delay in the advance of the shuttle from spindle to spindle. At the second spindle station these holes are finish-reamed, and at the third station the 4 3/16-inch holes are rough-bored with a boring-bar having a long pilot which extends into the previously finished holes. There are two of these large holes in which the rotary pump gears operate, and as they overlap, the use of a pilot for the boring-bars is essential in order to overcome the tendency of the tools to run out. At the fourth spindle station these two holes are finish-bored with a tool of the same type as that employed in the third spindle.

All drill, reamer, and boring-bar holes in the box are bronze-bushed, and the last bushing plate has four knurled feeler screws which are screwed down on the top of the shuttle to steady it and remove all likelihood of its moving while the hole is being finish-bored. Stop-collars are provided on the boring-bars to obtain the correct depth, which is held to gage limits. A plug gage, such as is shown resting on the top of the shuttle box, is also employed to check the diameters of these holes.

Jigs of this type are used for machining cases of various sizes, and when a different depth of bore is required, separate collars are used on the boring-bars under the regular stop-collars. It was stated that the shuttles are open at both ends, which makes them easily accessible for loading. It will also be noticed that the tracks on which the shuttles rest are high so that a pan can be placed between them to catch the chips from the tools and prevent the passageway of the shuttles from being clogged up. At the right in Fig. 1 may be seen another machine equipped similarly to the one

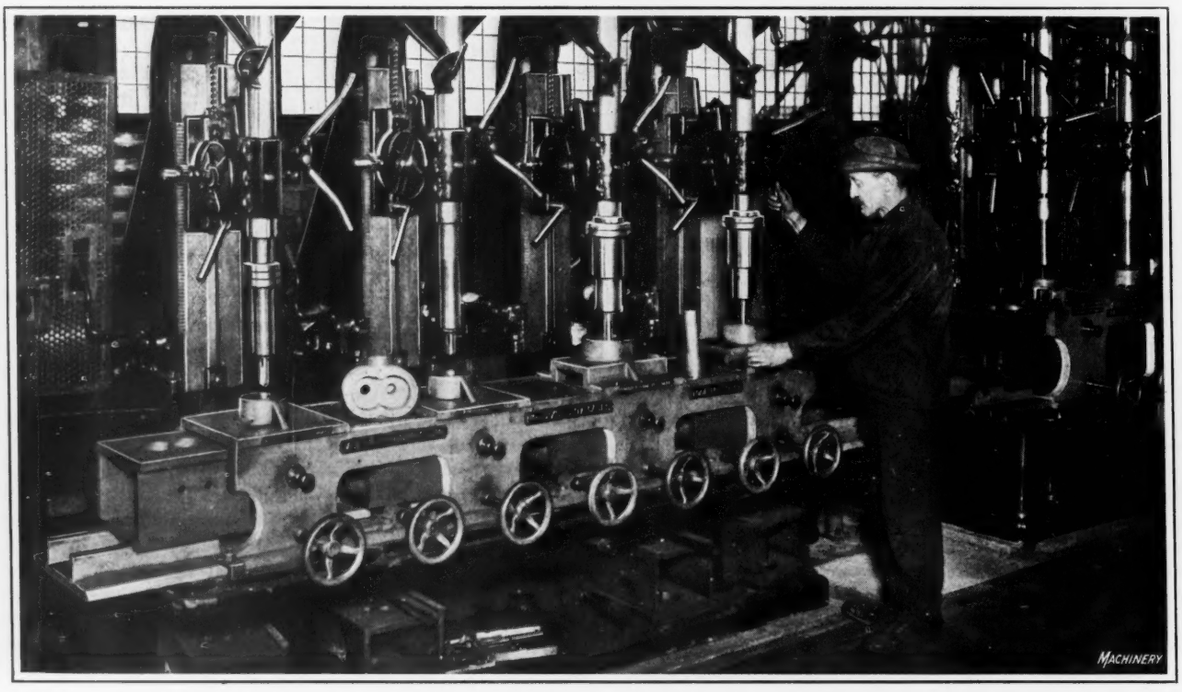


Fig. 1. Four-spindle Gang Drilling Machine with Box Jig and Work-holding Shuttles which travel from Station to Station

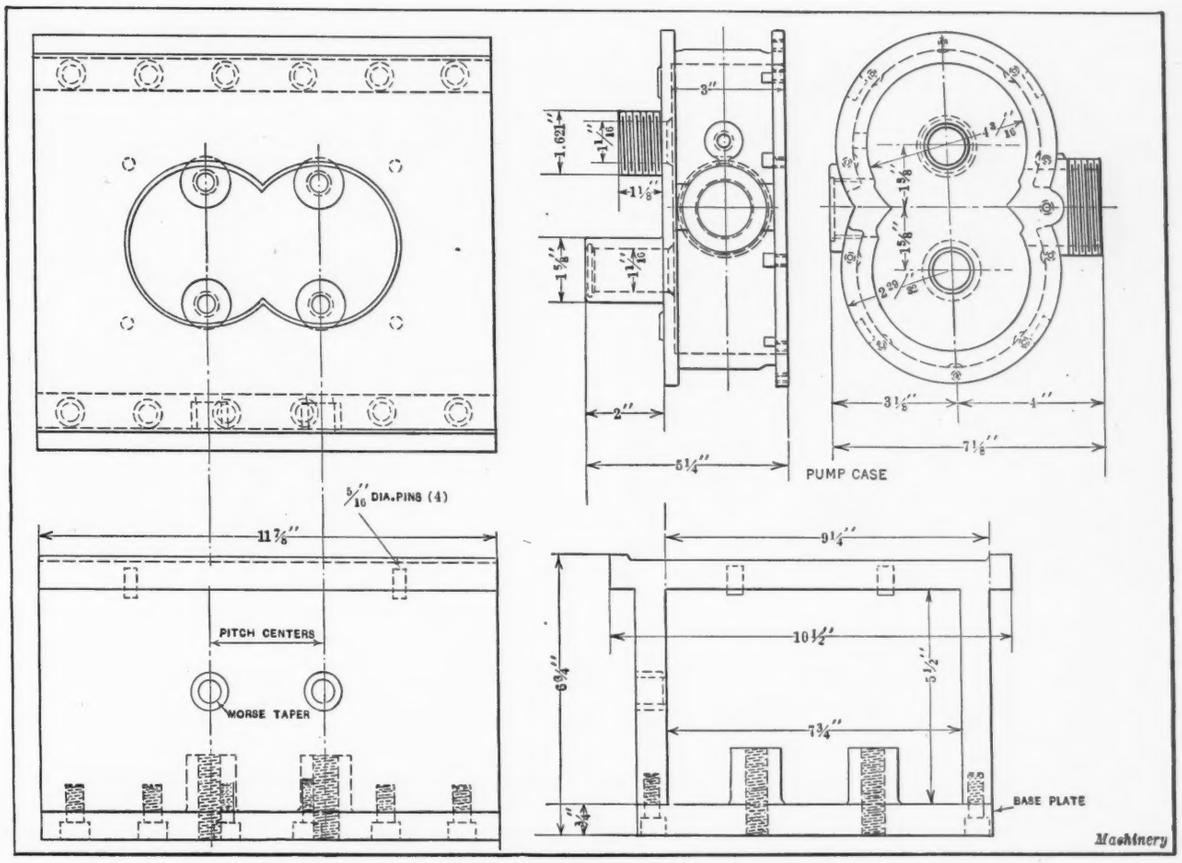


Fig. 2. Rotary Pump Case and Shuttle Jig in which it is bored

to which reference has been made, and here the covers for the cases are machined. Both machines are attended by one operator who thus produces one complete case and cover when the last shuttle is unloaded from each machine.

* * *

WORK OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE

The American Engineering Standards Committee, which consists of representatives from five departments of the Federal Government, nine national engineering societies and fourteen national industrial associations, has recently issued a report which sets forth in detail the activities of the committee during 1921 in national standardization in the engineering field. This committee, which was organized January 17, 1917, at a meeting of a special committee appointed jointly by the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, now has the cooperation of one hundred and sixty bodies of national importance. These cooperative bodies have designated more than five hundred persons as official representatives to serve on sectional committees working under the auspices of the American Engineering Standards Committee.

The object of the American Engineering Standards Committee is primarily to serve as a national clearing house for engineering and industrial standardization, to act as the official channel of cooperation in international standardization, and to provide an information service on engineering and industrial standardization matters. Since the committee functions as a clearing house rather than as a creator of standards, its work necessarily centers in bringing about systematic cooperation of the organized bodies—technical, industrial and governmental—which speak for industry.

During the past year a good foundation has been laid for a really effective information service on standardization. It is planned that a complete file of all American and foreign standards of significance shall be maintained for the free use, not only of the committees working under the auspices of the American Engineering Standards Committee, but of all American industries generally. The file now includes complete sets of standards approved by all national standardizing bodies, and a majority of the standards issued by the important organizations in this country.

During the year, seventeen standards have been approved by the committee, while seventy-nine projects have reached an official status. In the mechanical division specifications for pipe threads have been approved. In the metal divisions, specifications for Bessemer and open-hearth steel for cold-drawn automatic screw stock have also been approved. Of more general interest is the substantial progress reported on safety codes. The safety code program now includes twenty-nine codes for which definite arrangements have been made. The three following codes have been approved: the national electric code, the safety code for industrial lighting, and the code for the protection of the heads and eyes of industrial workers. The National Safety Code Committee serves as a committee for the general program, delimiting specific projects to be advantageously handled as distinct codes, recommending sponsors, assisting in caring for overlaps, and reporting on the progress of the program.

A general scheme for the plan and arrangement for safety codes has been developed and published for the guidance of those interested in the formulation of such codes, in order that there may be as great a degree of uniformity between the various codes as possible.

Copies of the national standards that have been approved by the committee as well as copies of foreign specifications and standards are available to American industries through the headquarters of the committee at 29 West 39th St., New York City.

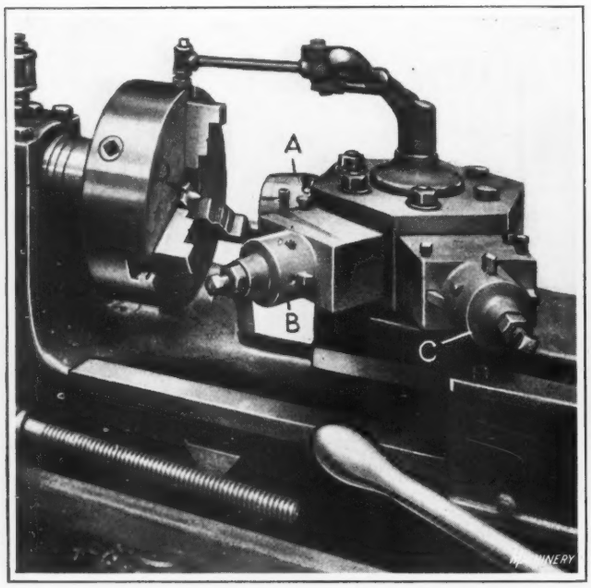


Fig. 1. Turret Lathe on which the Open End of the Piston Casting is bored, faced, and chamfered, and the Boss is centered

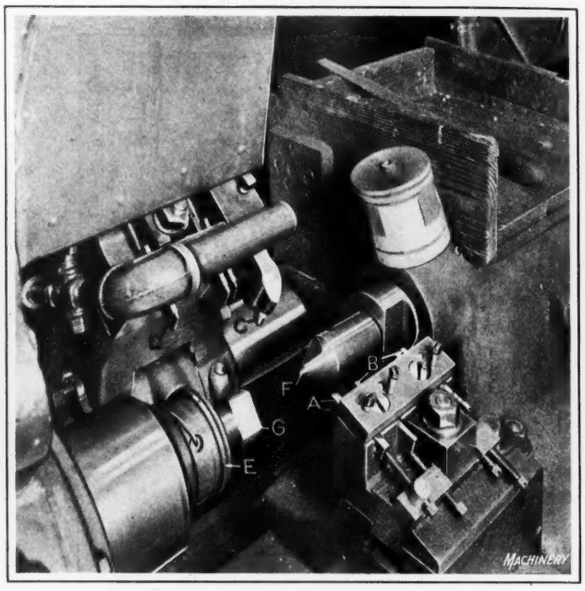


Fig. 2. Automatic Lathe tooled up for facing Closed End, turning Outside Diameter, and roughing and finishing Piston-ring Grooves

Tooling Equipments for Pistons

Use of Automatic Machines and Special Equipment for Machining Lynite Pistons at a High Rate of Production

By EDWARD K. HAMMOND

THERE are few industries in which production methods are more carefully scrutinized than in the manufacture of automobiles. In this industry the methods are constantly being checked over and improved, with the result that standards of efficiency and rates of production are steadily being brought closer to the maximum. The use of automatic lathes and turret lathes provided with special tooling equipments for machining pistons in a large automobile factory offers an interesting example of high-production methods. The pistons are made from lynite die-castings, and the high cutting speeds employed are possible because of the use of this material. This article explains, step by step, the procedure in manufacturing these parts, and the accompanying table gives the cutting speed and production for each operation.

As the castings are delivered to the piston department, the first step is to subject them to a visual inspection, after which the work is transferred to a Warner & Swasey turret lathe equipped as shown in Fig. 1. This machine bores, faces and chamfers the open end *a* of the piston casting, Fig. 4, and centers the opposite end at *b*. It will be seen in Fig. 1 that there is a block *A* on the turret at the first station, which pushes the work back into the chuck while it is being clamped in place. On the second face of the turret there is a combination rough-boring and rough-facing tool *B*; and on the third face there is a combination finish-boring, finish-facing, and chamfering tool *C*. The center drill *D*, which produces a hole in the boss *b* cast at the closed end of the piston for that purpose, is mounted on a spindle extending through the hollow main spindle and connected to the bar feed mechanism. The spindle on which drill *D* is mounted rotates in the opposite direction from the main spindle. As the work is rotated by the chuck, the drill can be fed through the spindle into contact with the boss.

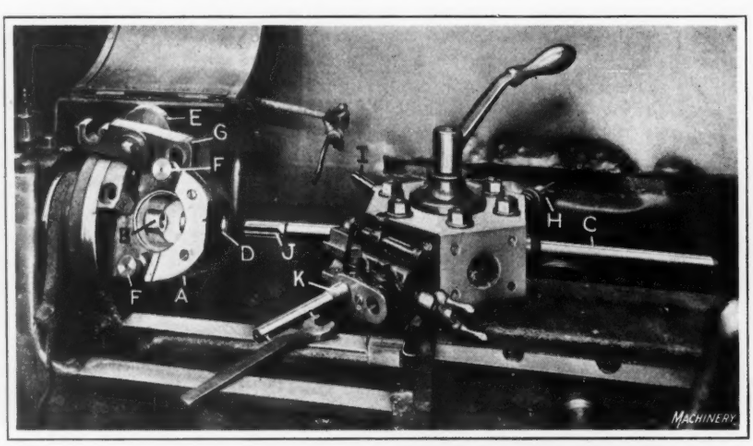


Fig. 3. Turret Lathe equipped for drilling, boring and reaming the Wrist-pin Holes and cutting the Locking Ring Grooves

Finish-facing the Closed End, Turning the Outside Diameter, and Roughing and Finishing the Ring Grooves

Next, the piston castings are sent to a Fay automatic lathe which is tooled up for finish-facing the top end *c*, Fig. 4, turning the outside diameter *d*, and roughing and finishing the piston ring grooves *e*. The front slide feeds from right to left, for turning the outside diameter with tool *A*, Fig. 2, and then moves inward to rough out the piston ring grooves with the three tools *B*. Meanwhile, the rear head swings down to face the top end of the piston with tool *C* and to finish-turn the grooves with the three tools *D*. The work is held between a center *E*, which enters the chamfered open end of the piston and another center *F*, which enters the hole drilled in the boss at the closed end. Driving is accomplished by means of a plug *G* on the spindle, which fits into the space in the piston between the inner ends of the wrist-pin bosses.

OPERATIONS ON PISTONS AND PRODUCTION TIME

Oper. No.	Operation	Type of Equipment	Cutting Speed, Feet per Minute	Prod. Time, Minute	Hourly Prod.
1	Inspect	Bench	.....	.....	.....
2	Bore, face, and chamfer skirt a and center boss b*	Warner & Swasey turret lathe	815	1.05	57.0
3	Face closed end c, turn outside diameter d, and rough and finish ring grooves e	Fay automatic	360	1.23	49.0
4	Drill, bore, and ream wrist-pin holes f and cut locking ring grooves	Warner & Swasey turret lathe	150	1.60	37.5
5	Mill faces g	Briggs milling machine	245	0.30	200.0
6	Chamfer faces h	Burke milling machine	120	0.42	143.0
7	Drill two oil-holes in faces h	Leland-Gifford drilling machine	60	0.63	95.0
8	Chamfer wrist-pin holes at i	Sipp drilling machine	200	0.22	273.0
9	Drill four oil-holes j	Sipp drilling machine	40	0.27	222.0
10	Mill oil-grooves in wrist-pin holes f	Sipp drilling machine	160	0.34	176.0
11	Grind clearance k	Landis grinding machine	5700	0.56	107.0
12	Center open end a	Special machine	750	0.185	325.0
13	Rough- and finish-grind outside diameter d and clearance on lands l and m	Special grinding machine	5700	1.34	44.8
14	Remove center boss b	Sipp drilling machine	275	0.28	214.0
15	Finish-ream wrist-pin hole f	Special machine	160	0.63	95.0
16	Mark center lines on face c	Bench and gage	.....	0.15	400.0
17	Wash and dry	Tank and cloths	.....	0.10	600.0
18	Final inspection	Bench	.....	.....	.....

Machinery

*For notation see Fig. 4.

Machining the Wrist-pin Holes

After the Fay automatic has completed its work, the piston castings are transferred to a Warner & Swasey No. 4 turret lathe to have the wrist-pin holes *f*, Fig. 4, drilled, bored and reamed, and to cut the locking ring grooves in these holes. A machine tooled up for this work is shown in Fig. 3. A pot fixture *A* is carried on the spindle nose. Into this fixture the piston casting *B* is inserted, being located by means of a pilot bar *C* on the first turret face, which extends through bushing *D* in the fixture and through the wrist-pin hole in the work. The work is then clamped in place by means of a plug *E*, which enters the chamfered open end of the casting and is secured by means of bolts. The ends of strap *G* are slotted to slip under the heads of two bolts *F* after they have been loosened slightly.

Having secured the casting in place, the wrist-pin hole is first roughed out with a core-drill *H*, on the second turret face, and then bored and reamed with the usual types of boring-bar *I* and reamer *J* on the third and fourth turret faces. The locking ring grooves are next cut in the wrist-pin hole by a tool *K* on the fifth face of the turret. This tool is mounted on a cross-slide, which is fed transversely to sink the two grooving tools into the work to the required depth. It is known as a cross-slide under-cutting tool, and is made by the Warner & Swasey Co. for use on turret lathes of its manufacture. To maintain the required accuracy of alignment, bushings are provided in the pot fixture *A* at each side of the work, to receive guiding pilots on the tools.

Facing the Wrist-pin Bosses

The next step in machining these pistons is to face the ends *g*, Fig. 4, of the wrist-pin bosses perpendicular to the finished holes *f*. This is done on a Gooley & Edlund, Briggs type of milling machine, which is shown in Fig. 5 equipped with a work-holding fixture *A* and a special offset cutter-head *B*. The piston casting *C* is slipped into the split cylindrical fixture and located by a plug *D* which enters the wrist-pin hole. The work is clamped by tightening a screw *E*, which passes through threaded bosses at each side of the split top of the fixture. By traversing the table, the work is fed up to the offset milling cutter *B*, which is held in such a way that it can enter the open end of the piston. The cutter is driven by gears to which motion is transmitted by a gear *F* carried on an arbor held in the milling machine spindle. The entire fixture is suspended from the over-arm.

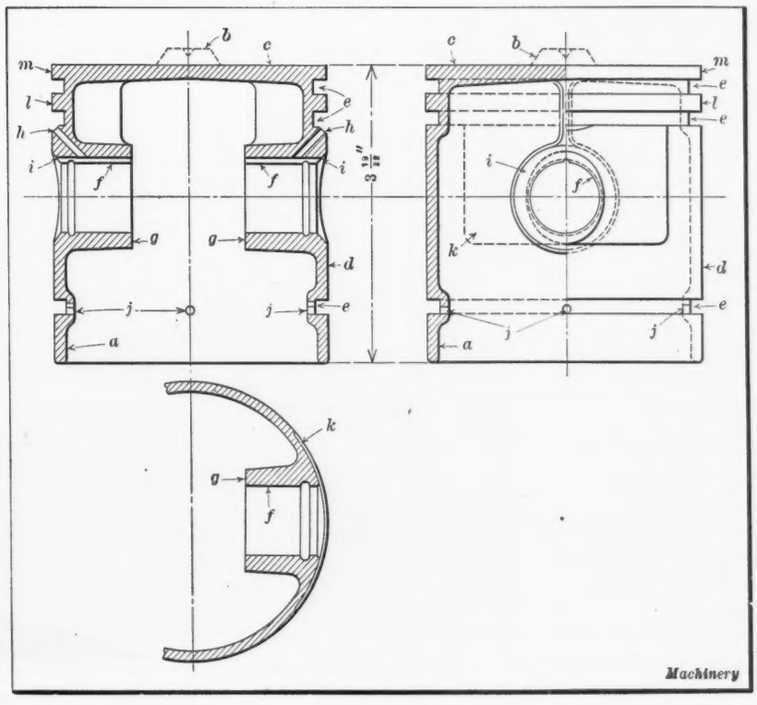


Fig 4. Piston on which Machining Operations listed in Accompanying Table are performed

Milling Chamfers on the Middle Piston-ring Groove

It is necessary to mill a chamfer *h*, Fig. 4, on the lower side of the middle piston-ring groove, directly above each end of the wrist-pin holes *f*. This is done on a Burke hand milling machine, equipped with a fixture, as shown in Fig. 6. The piston is located on a pilot *A* carried by the bed of the fixture, and is held down by a clamp *B* having a hand-lever *C*, by means of which the necessary pressure is exerted. Very little time is required to set up the job in this way. The work is traversed past an end-mill *D*, which cuts the chamfer on the middle piston-ring groove.

Drilling Oil-holes

Next in the order of machining operations comes the drilling of two oil-holes *h*, Fig. 4, which extend diagonally from the middle piston-ring groove in to bearing holes *f* for the wrist-pin. Fig. 7 shows a Leland-Gifford sensitive drilling machine, equipped for this operation. A pilot extension on disk *A* fits into the bored skirt, and a smaller pilot extends up into the piston, which has a hole in it through which pin *B* can be slipped. This pin also extends through the wrist-pin holes in the piston and provides for clamping the work by tightening screw *C*,

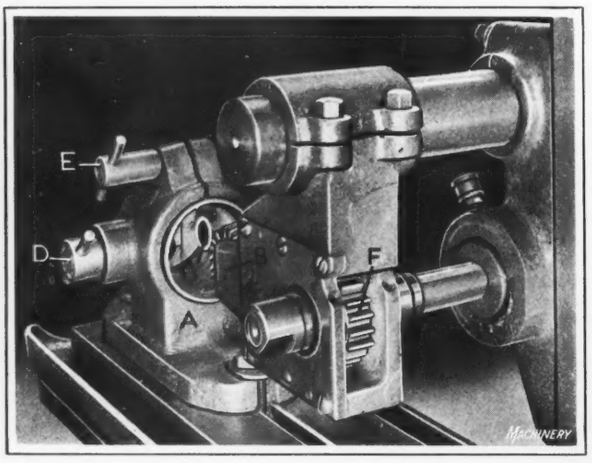


Fig. 5. Milling Machine equipped for facing Inner Ends of Wrist-pin Bearing Bosses

which draws the small pilot and pin *B* in toward the base of the fixture. The pilot is splined so that it cannot turn, and pin *B* serves the additional purpose of locating the oil-

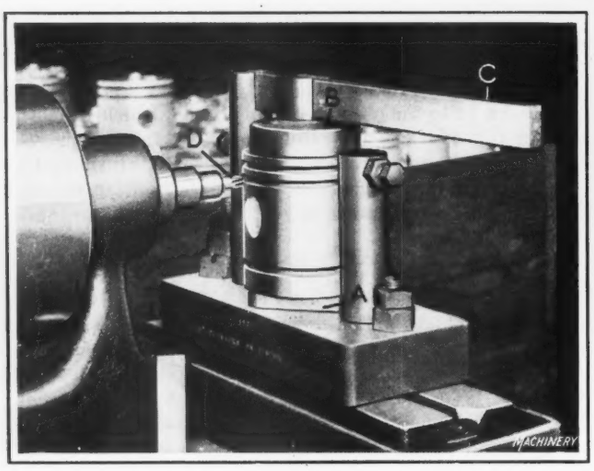


Fig. 6. Hand Milling Machine equipped for chamfering the Lower Side of the Middle Piston-ring Groove

holes in the proper relation to the wrist-pin bearings. The drill bushing is located at *D*, and after one of the two holes *h*, Fig. 4, has been drilled, the work is released from the fixture and reset 180 degrees from its first position, for drilling the second hole.

Next, the outer ends *i*, Fig. 4, of the wrist-pin holes *f*, are chamfered with a cutter *A* on a Sipp upright drilling machine, the work being held in a V-block *B* as shown at the left-hand side of Fig. 8. Then the casting is transferred to a similar fixture shown at the right-hand side of the illustration. The spindle in this machine carries a twist drill *C*, which is used to drill four oil-holes *j*, Fig. 4, in the lower piston-ring groove, distributed equally around the circumference of the work. Oil-grooves are then milled in the wrist-pin holes with a cutter carried in the spindle of a Sipp drilling machine.

Grinding Clearance at Ends of Wrist-pin Holes

It is required to grind a clearance of from 0.010 to 0.015 inch under the sliding surface of the piston over an area adjacent to each end of the wrist-pin bearings, and for this operation a Landis cylindrical grinding machine is used. The form of the clearance to be ground is clearly indicated at *k* in Fig. 4. The work is held at one end by an ordinary center *G*, Fig. 9, while a special center *F* at the other end enters the finished opening *a*, Fig. 4, at the base of the skirt. The Landis grinder is equipped with a fixture shown on the machine at *A* in Fig. 10, and details of its design are more clearly illustrated in Fig. 9.

The piston is rotated in unison with a cam *B* (see Fig. 9), which is finished to the shape and size of a cross-section of the finished piston, through the centers of the wrist-pin holes *f*, Fig. 4. This cam runs in contact with a fixed roller *C*, and as the entire work-holding fixture is pivoted on the grinding machine, the cam carried by the fixture and the

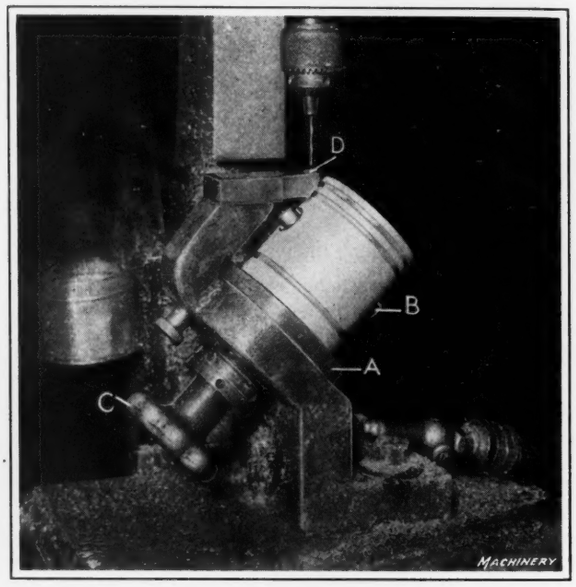


Fig. 7. Jig for drilling Two Inclined Oil-holes leading to Wrist-pin Bearings

roller secured to the frame of the machine oscillate the fixture on its pivotal support *D*, in such a way that the work is swung in contact with the grinding wheel and is ground to the same form as the cam.

The method of operation of the fixture is as follows: The piston *E* is carried between centers *F* and *G*, and a plug *H* extends inward, engaging the ends of the wrist-pin bosses, and thus affording a convenient method of driving. The live center *F* and the cam *B*, which controls the form of clearance ground on the work, are both carried by a spindle which

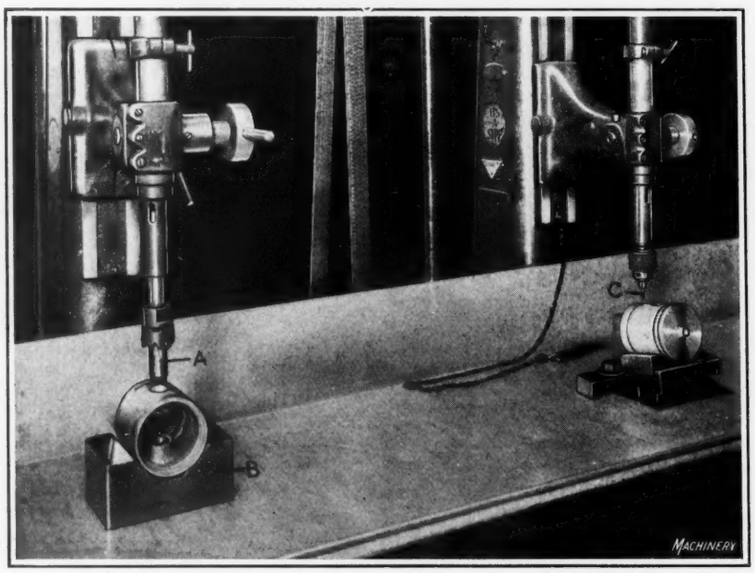


Fig. 8. Drilling Machine equipped for chamfering the Outer Ends of the Wrist-pin Holes, and for drilling Four Oil-holes in the Lower Ring Groove

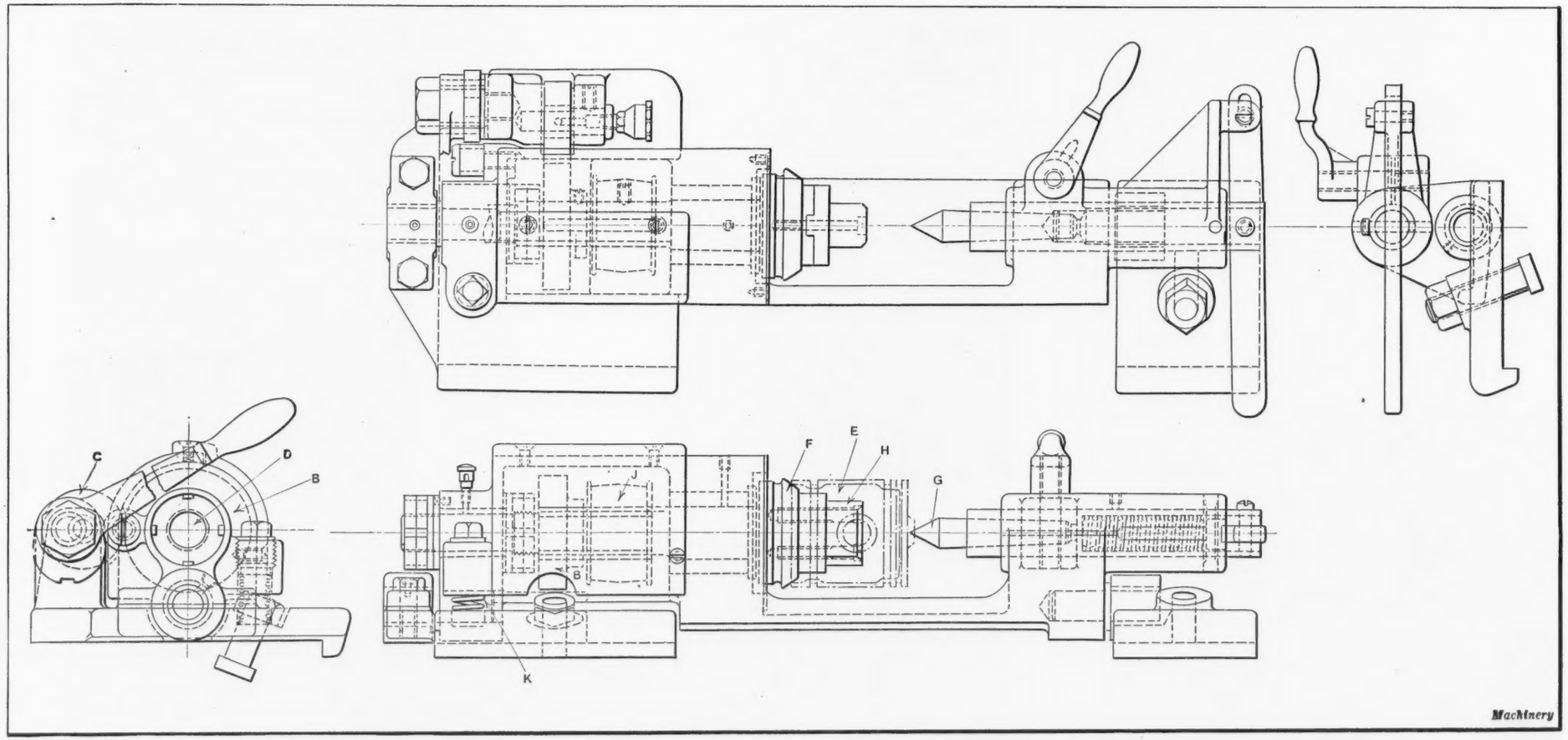


Fig. 9. Details of Design of the Grinding Machine Attachment shown in Operation in Fig. 10

is positively driven from below by means of a Morse silent chain *I*, Fig. 10, running over sprocket *J*, Fig. 9. Uniform contact is maintained between cam *B* and roller *C* by means of two springs *K*, and the action of these springs is supplemented by two additional springs *L*, Fig. 10.

Centering the Open End and Grinding Outside of Piston

After the clearance *k* has been ground, it is necessary to recenter the open end of the piston, as the chamfer formerly machined is not accurate enough to be depended upon for locating the work for rough- and finish-grinding the outside diameter *d*, Fig. 4. For this purpose the pistons are centered on a special machine, after which they are set up on a special cylindrical grinding machine on which the outside diameter *d*, of the work is rough- and finish-ground. Provision is also made at this setting of the work for grinding the clearance on lands *l* and *m* at the top of the piston. The work is shown in Fig. 11 set up for this operation. It is held by a center *A* entering a hole in the closed end of the piston, and a center *B* entering the open end of the work.

Removing the Center Boss at Top of Piston

After the pistons have been rough- and finish-ground, the center boss is no longer needed, and so it is removed by a Sipp drilling machine equipped with a work-holding fixture *A* and end-milling cutter *B* of the type shown in Fig. 12. The piston is located in the fixture by means of a pilot *C* which enters the finished wrist-pin hole, after which handle *D* is turned to raise the supporting table *E* into contact with the bottom of the work. Then the end-mill comes down through a guide bushing *F* at the top of the fixture, and cuts off the boss so that it is flush with the top of the piston.

Next the wrist-pin holes *f*, Fig. 4, are finish-reamed on a special machine. Finally, two lines are scribed across the top of the piston as shown in Fig. 13. The piston is located in a fixture *A* by a pin *B* passing through the finished

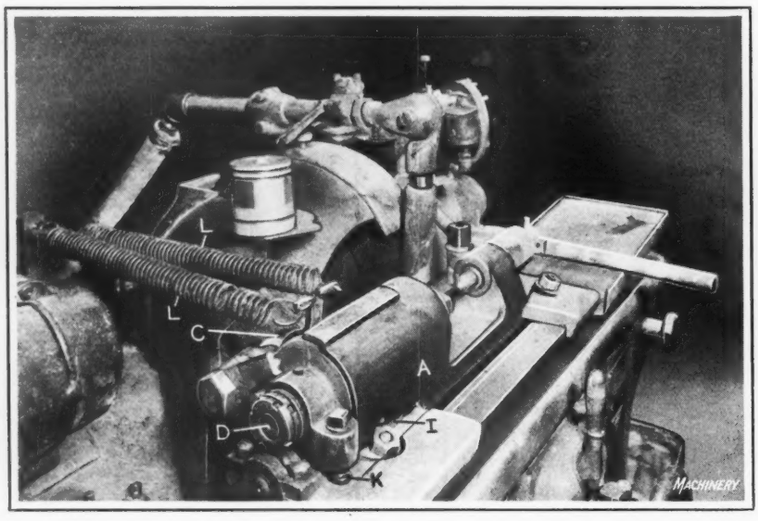


Fig. 10. Special Attachment for grinding Clearance Space at the Outer End of each Wrist-pin Hole

wrist-pin hole, and by a sliding block *C* on the surface plate, on which the work-holding fixture is carried. Block *C* carries two cutting points *D* and *E* which scribe the required lines across the work. The pistons are then washed, wiped, and inspected, and marked for size and weight, after which they are ready to be assembled.

* * *

INDUSTRIAL MACHINERY IN EGYPT

The imports of industrial machinery into Egypt have increased greatly during the last three years. In 1919 the total imports of this class of machinery into Egypt from

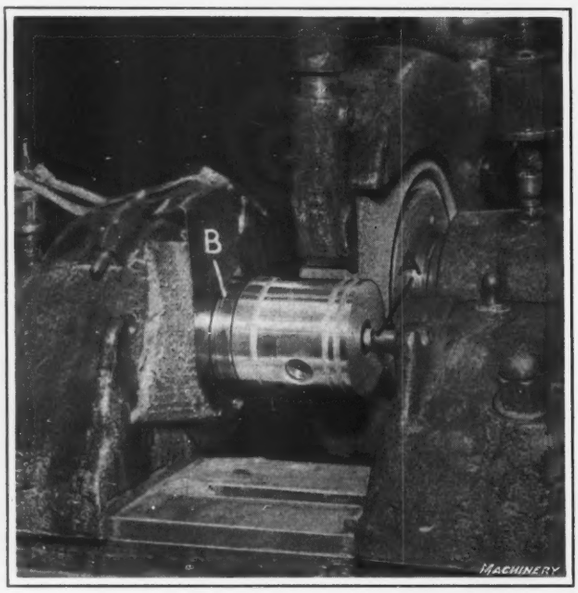


Fig. 11. Cylindrical Grinding Machine equipped for grinding the Outside Diameter and the Clearance on the Two Upper Lands

all countries amounted to about $2,100,000, rising in 1920 to $6,750,000, and in 1921 to nearly $10,000,000. Of these imports 12.3 per cent were from the United States in 1920, and 29.6 per cent in 1921. The imports in the latter year included 49 locomotives built by American firms for the Egyptian state railways. The market for industrial machinery in Egypt is not large, and the largest single item in 1921, outside of locomotives, was stationary internal combustion engines. The countries that contributed to the imports of industrial machinery into Egypt in 1921 in the order of their importance in this trade were: the United Kingdom, France, Germany, the United States, and Switzerland.

MOTOR TRUCK TRANSPORTATION

Although the motor truck is gaining in importance daily as a means of transportation, both for local purposes and in interurban service, there is no danger that it will ever replace the railroads for long distance hauls. An investigation has shown that compared with the tonnage moved by the railroads, the work done by trucks in interurban service is quite small. Between New York and Philadelphia, for example, where there is a highly developed truck service, the trucks do not carry more than one-half per cent of the total amount of freight transported. In the great majority of cases, the trucks handle small package business—a business which at best is not very profitable to the railroads, and which is sometimes even carried at a loss. The transfer of this business to the commercial truck is a logical development of our transportation system. It is economical from every point of view, and it causes no loss to the railroads. The motor truck fills a definite place of great value in the transportation system, and it will undoubtedly be

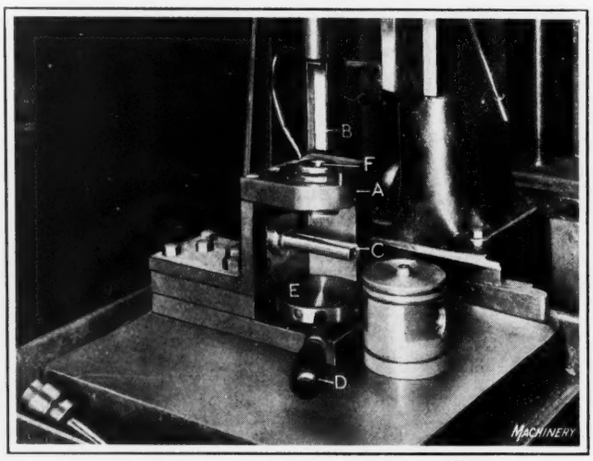


Fig. 12. Drilling Machine equipped with Special Milling Cutter for facing off the Boss on the Closed End of the Piston

used increasingly in certain classes of work, but it will never replace the railroad as the chief hauler of freight.

* * *

There are more than a million wireless receiving sets in use in this country at present, contrasted with 30,000 a year ago, and the number is growing at a rapid rate.

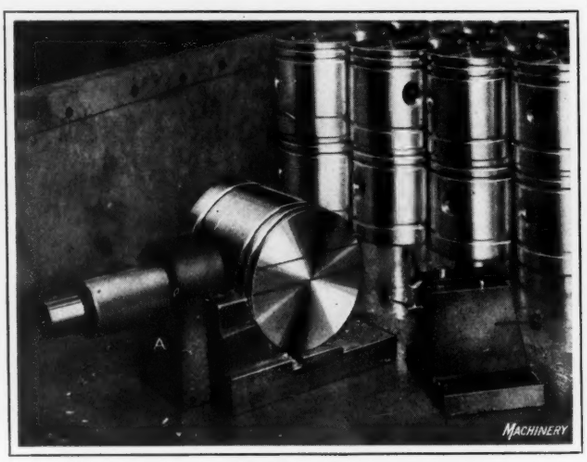


Fig. 13. Tools used for scribing Two Reference Lines across the Closed End of Each Piston for Guidance in assembling

DRIVING CHUCK FOR AUTOMATIC LATHE

By E. M. BIDWELL

Among the various types of lathe drivers or dogs designed for the automatic chucking of cylindrical work, the writer could not find any which seemed to be suitable for the conditions encountered in chucking the automobile clutch or main drive gear illustrated in Fig. 1. Consequently, a special driving chuck was designed, which is quick-operating and which furnishes a positive drive when machining the

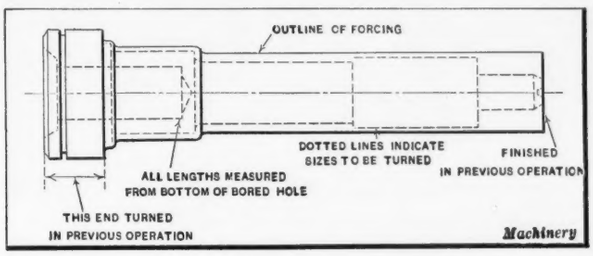

OUTLINE OF FORCING
DOTTED LINES INDICATE SIZES TO BE TURNED
FINISHED IN PREVIOUS OPERATION
ALL LENGTHS MEASURED FROM BOTTOM OF BORED HOLE
THIS END TURNED IN PREVIOUS OPERATION
MacMinery

Fig. 1. Automobile Clutch Gear Forging for which Chuck shown in Fig. 2 was designed

forgings in a Fay automatic lathe. This clutch gear is turned down from the rough-forging size to the finished shape shown in dotted lines. Six turning and four facing tools are used in machining this forging, and consequently a very strong and positive drive is required. For this reason it was not thought advisable to use the ordinary set-screw lathe dog. Those familiar with the operation of the Fay automatic lathe know that a large amount of lost time and production will result if a driving dog that slips is used.

Features of Construction

Before the forging goes to the automatic lathe to be turned, the hole in the gear end is bored and the outside diameter of the gear rough-turned, so it is only necessary to provide for a variation of 1/16 inch on the diameter, in designing the driver. This special tool (see Fig. 2) consists of a body *A* which is recessed on one side to fit over the regular faceplate of the lathe, in place of the floating faceplate provided on the machine, and is attached by four fillister-head screws, using the same key as is used in attaching the floating plate. The body is made of machine steel, and is cut out to accommodate the ring *E*, a ⅛-inch floating movement being allowed for the ring. The ring is held in place by a retaining plate *C*, fastened to the body by screws and dowel-pins. The floating ring carries two hardened steels jaws *G*, which are dovetailed and located in the plate in the position indicated.

The top part of the floating ring is cut out on both sides, as is also a section from ring *C*, so that the driving pawl *F* can be assembled by straddling the section in ring *E*, in which position it is held in place by a ⅞-inch nickel-steel pin *D*. The shoulder against which the floating ring bears in the body is also cut away to correspond with the section that is removed from ring *C*, this being necessary on account of the design of the pawl *F*. The sections cut out for the accommodation of the upper end of the pawl are indicated at *K*, these surfaces being those against which the ears of the pawl contact when gripping and releasing the work, as will be explained later. The gripping end of the pawl contains serrated teeth and is hardened, and the surface in which these teeth are cut is eccentric with regard to the center of stud *D* on which the pawl swings when in operation.

The outside of the body of the chuck carries a handwheel which is corrugated to make it easy to grasp by the operator when it is covered with oil. When in operation, the weight of the handwheel rim acts as a flywheel, and its momentum aids in the operation of the chuck. The handwheel carries a finger *H* which is fitted into it and which extends through the body of the chuck and into a slot cut in floating ring *E*; this slot provides sufficient clearance so that the finger does not interfere with the floating movement of the ring. A section of the body of the chuck is also cut out as indicated at *J*, for approximately 90 degrees, which permits the handwheel to revolve nearly a quarter of a turn before its movement is arrested by the finger *H* on the handwheel coming into contact with the surfaces *J*.

Operation of the Driving Chuck

The live stub center of the lathe is made a sliding fit in the end of the clutch gear, and this stub center extends beyond the driver a short distance so that when the work is placed in the machine it is simply necessary to slip the gear over this center and bring the tail-center into engagement with the opposite end of the gear. The work is advanced on the plug center by pushing up the tailstock until the stub center bottoms in the hole in the gear. Jaws *G* are beveled on their inner edge, so that when the work is centered in the position described the floating ring *E* will be moved sufficiently to admit the work readily. The machine is then started, revolving the body *A* and retaining ring *C*, and bringing surface *K* into contact with the pawl, which causes it to swing on pin *D* until the serrated teeth grip the work. The continued rotation of the chuck transmits a rotary movement to the work which is thus positively driven, and any resistance to rotation produced by the cutting action of the tools only tends to tighten the grip of the chuck on the work.

In releasing the work after the machine has stopped, the operator grasps the handwheel and gives it a slight turn, just enough to bring the pawl *F* into contact with the surface *K* at the opposite end of the cut-out section, and thus swing the pawl in the opposite direction. This requires but little effort on the part of the operator on account of the flywheel effect of the handwheel, the momentum of which greatly aids in the disengagement of the pawl. For example, when a finishing cut is taken on this forging, the driver automatically releases itself, due to the momentum of the handwheel, by disengaging the pawl, when the machine comes to a quick stop, as it does when the brake attachment provided on the Fay lathe is used. When the machine comes to a stop, the pawl is swung so as to permit plenty of space for convenience in chucking another forging, so that after each piece is put between centers, all that is necessary is to start the machine.

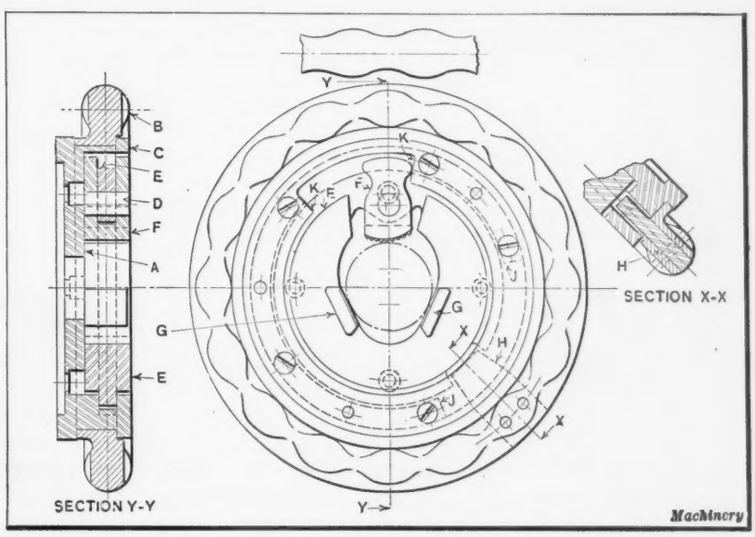


Fig. 2. Driving Dog or Chuck designed for gripping the Clutch Gear while being machined

Production Work in a Contract Shop

Manufacturing Methods Employed in the Plant of the Taft-Peirce Mfg. Co. Woonsocket, R. I., in Machining Automobile Parts—Second of Two Articles

IN the first installment of this article published in April MACHINERY, the equipment used by the Taft-Peirce Mfg. Co. for grinding, drilling, reaming, and inspecting the valve followers of the Wills Sainte Claire engine, and methods used in the production of the camshaft drive pinion floating washer were described. The present article deals with operations on the camshaft drive shaft bearing retainer, the motor fan, and the intermediate and fan shafts.

Camshaft Drive Shaft Bearing Retainer

The camshaft drive shaft bearing retainer consists of an upper and a lower member, both iron castings, on which probably the most interesting operation is that of facing one end and the under side of the flange, as shown in Fig. 10. This illustration also gives a good idea of the design of these castings. The two tools are carried in the back-facing attachment of a Porter-Cable lathe. A tolerance of 0.002 inch on the distance from the small end of the casting to the inside wall, through which eight holes are drilled, is allowed, this distance being nearly 3 inches. For finish-facing the flange, a limit of 0.0005 inch is specified between this face and the small end of the casting. Limit length gages are provided to check these distances. The work is mounted on a special arbor, which is shown lying on the carriage of the machine. A shouldered pin is driven into an ear on the arbor to act as a driver. The arbor fits snugly in a brass bushing previously assembled in the casting, with the small end of the pin fitting into one of the previously drilled holes in the flange. The back-facing attachment employs the cam-feed mechanism regularly furnished with this type of lathe.

Fig. 11 shows a special gaging device used for inspecting the concentricity of the two finished diameters of the retainer castings. This consists of a large surface plate to which a stand is bolted. The stand furnishes a bearing for the long bar and centers shown, these being regular Springfield straightening-press equipment applied to this inspecting device. One center has been changed to include a heavy expansion spring and a hand-lever *A* for withdrawing the center against the pressure exerted by this spring. Thus it is possible to center the arbor, over which the work is slipped for inspecting, by simply depressing this lever to withdraw the spring center before locating the arbor in the center at the opposite end of the bar. The lever is then released and the spring center advances into contact with the arbor. This holds the arbor with just enough tension to permit the inspector to revolve the work freely. A dial indicator is used, as shown in the illustration, for determining the amount of error in concentricity of the two diameters.

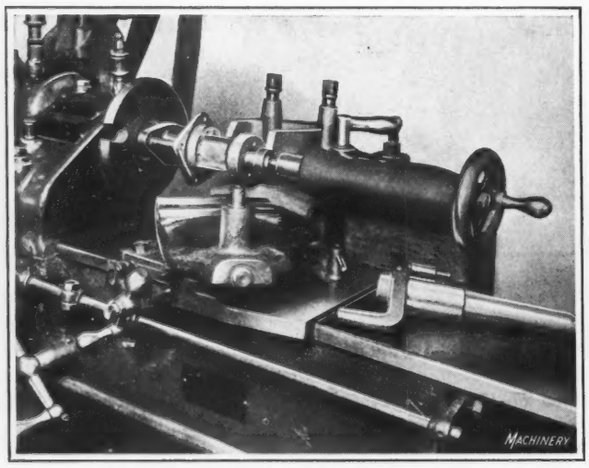


Fig. 10. Multiple Facing Operation on the Drive Shaft Bearing Retainer Casting

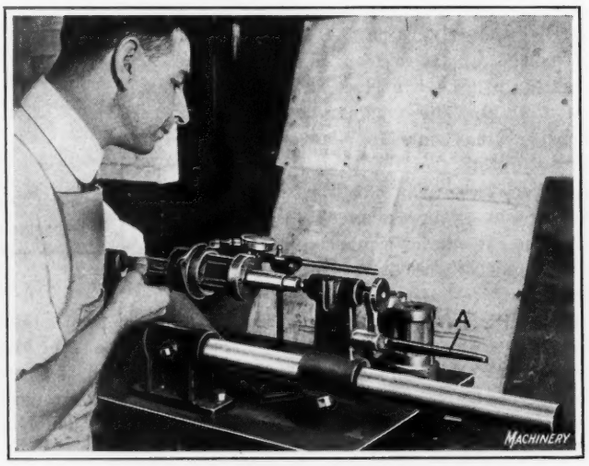


Fig. 11. Inspecting the Retainer Casting for Concentricity of Diameters

Machining the Motor Fan

The motor fan is an aluminum casting, and because of its peculiar shape some interesting machining equipment is employed. A detailed view of the fan is shown in Fig. 12. The first operation to which attention is called is that of chucking, boring, and reaming the hub, squaring face *A*, grooving and chamfering. This work is performed in a 24-inch Gisholt turret lathe equipped with regular Gisholt tools and a facing tool in the cross-slide, which may be seen at *A*, Fig. 13. This view is primarily intended to show the method of chucking the fan rather than the tooling set-up.

so that the blades are gripped at one spot, thus preventing them from being distorted when the nuts are tightened to clamp the straps. The fact that three segment arm studs are provided as fulcrums for operating the chucking mechanism makes it unnecessary to revolve the faceplate when chucking or releasing the work.

Both holes in the fan hub are hand-reamed, using the locating fixture shown in Fig. 15, and a double-expanding Martell reamer. A steel bushing is provided in the fixture as a bearing for the locating plug which is used to locate the fan concentrically when it is first placed in position.

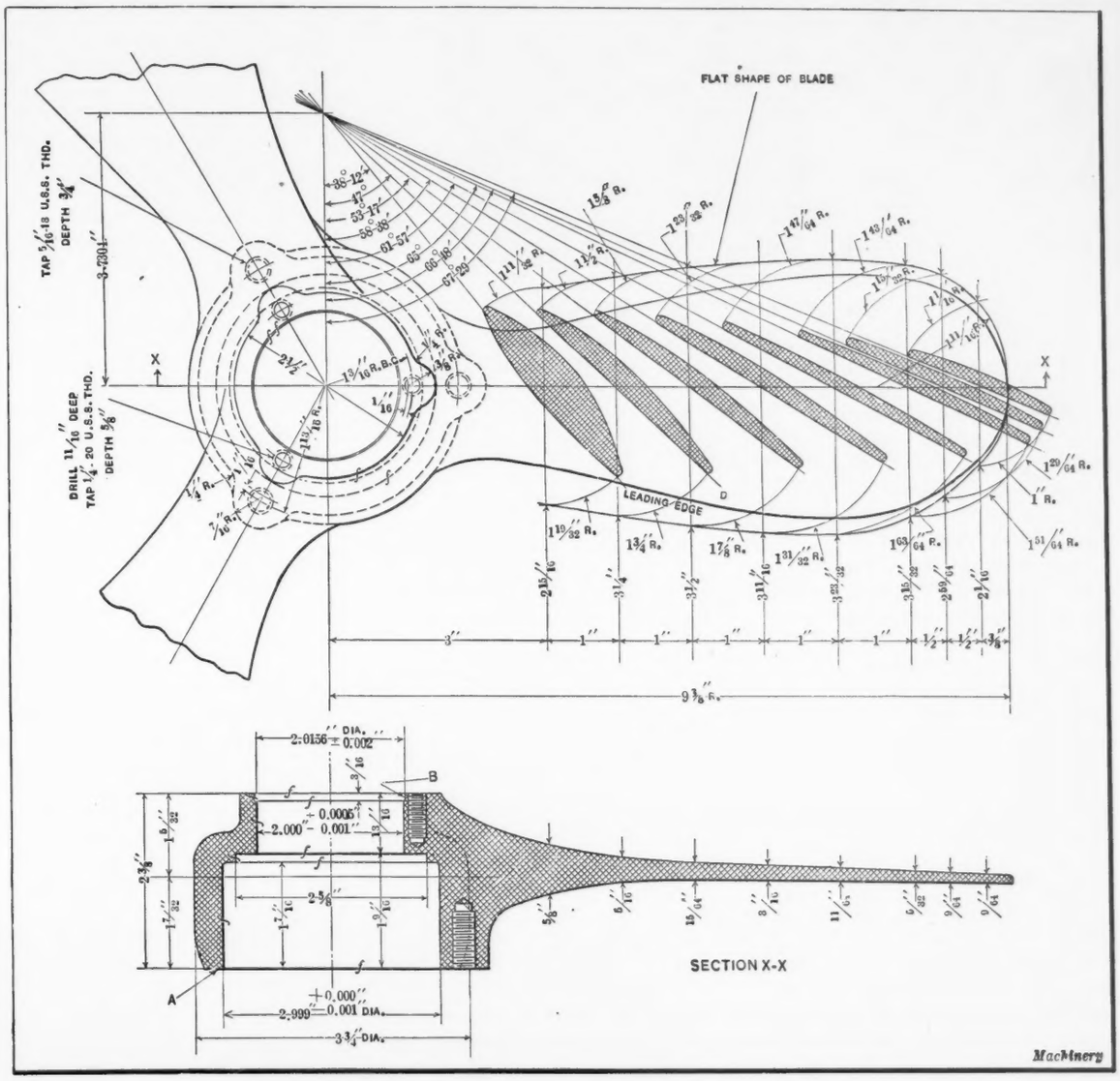


Fig. 12. Detail Views of the Aluminum Motor Fan of a Wills Sainte Claire Engine

A special fixture is bolted to the faceplate of the lathe, having a steel bushing to receive the pilots of the boring-bars and reamers employed in finishing the hole. The front plate of the fixture carries a gear of large diameter, in one side of which there is a cam groove, so that as the gear is turned in chucking the work, three pins are moved axially through the front plate, into engagement with the three bellcrank levers *B*, which causes the levers to swivel and grip the work on the hub between the blades of the fan. The fixture gear is operated by a segment arm *C*, in which there is a hole that fits over one of the three studs *D* extending from the inside of the front plate. The segment teeth engage the gear teeth and rock the bellcrank levers.

The fan is first placed in position for chucking, and given a slight turn forward until the blades enter between blocks *E* and the straps which they carry and are located against stops *F*. The blocks and the straps each carry a steel button, When the fan has been properly located, a floating clamp at the rear of the fixture is swung around until its end engages a stud in the main casting of the fixture. The illustration shows a fan in this position with the locating plug removed. The body of the Martell reamer is accurately ground to the same diameter as the locating plug, so that when the reamer is placed in the steel bushing, there is absolute assurance of the concentricity of the two holes. At the left of the vise in which this fixture is held, are shown two Taft-Peirce plug gages by means of which the limits on these holes are gaged. Fig. 12 shows that the tolerance on the diameter of the large hole is 0.001 inch, and on the small hole 0.004 inch.

Squaring the Hub, Balancing, etc.

The operation of squaring the hub and counterboring at *B*, Fig. 12, is performed in a Lodge & Shipley lathe, on the faceplate of which the special fixture shown in Fig. 14 is attached.

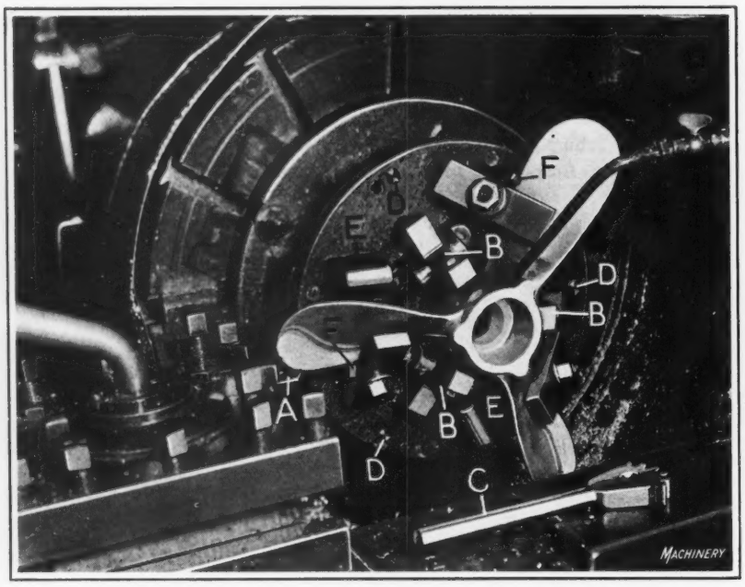


Fig. 13. Turret Lathe equipped with Special Fixture for chucking Motor Fan

This fixture is of the expanding type. Sleeve *A* is made of tool steel, spring-tempered, and has six slots so that when the expanding plug *B* is drawn in against the tapered hole, the fan will be located against shoulder *C* and securely chucked in this position. The end of the shank on plug *B* extends through the opening in arch bracket *D*, and carries a nut which is operated to draw in the plug. The angle of taper for this member is 15 degrees, this having been found a most efficient taper for rapid chucking. Only about one-fifteenth revolution of the nut on plug *B* is required in order to chuck the work securely.

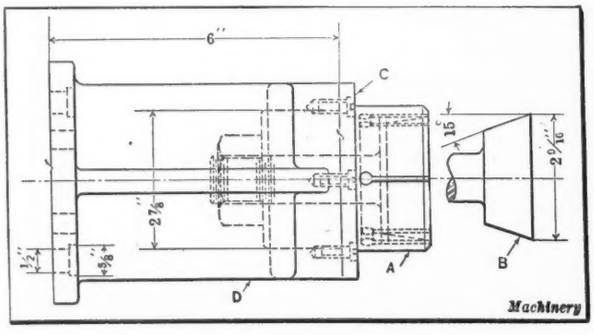


Fig. 14. Draw-in Expanding Fixture for chucking the Fan when squaring the Hub Face

After the fan has been completely machined, it must be balanced, and this is done with the aid of the Rockford balancing machine shown in Fig. 16. The tapered bushing assembled in the fan is engaged by a special tapered arbor, and the fan is placed in suspension between the disks of the balancing machine in the position illustrated. One of the arbors used is shown on the bench. After it has been determined which blade is too heavy to maintain static balance, the fan is clamped on another arbor and held in a bench vise while the metal at the edge of the heavy blade is scraped down or rasped with the square tool shown on the bench at the left of the vise. As in all specialized jobs of this kind, the workman must have a great deal of experience to do this work satisfactorily.

The bronze bushing previously assembled in the tapered hole of the fan receives a final finish-boring operation; this procedure differs from the usual practice of producing a highly finished surface. The method of finishing consists of using a diamond tool, and this has been found to give the most satisfactory results. Grinding could not be resorted to on account of the possibility of charging the bronze bushing with abrasive. The use of the diamond eliminates all such work as broaching or burnishing for producing the final finish. The fan is chucked against a special base clamped to the lathe faceplate by means of a large-headed bolt which screws into the base and seats against the inner shoulder of the fan. This job is set up in a Lodge & Shipley lathe, the faceplate of which revolves at a rate which gives a cutting speed of 180 feet per minute.

Intermediate and Fan Shafts

All shafts and other steel parts that are subjected to wear and strain are made of a special analysis molybdenum steel, which, on account of its satisfactory service where strength, toughness, and resistance to wear are prime requisites, is admirably adapted for use in automobile construction. The intermediate shaft shown in detail in the upper part of Fig. 17 is forged from this steel and finished in the following manner: After inspecting the forgings and testing them for hardness by the Brinell method, the shafts are straddle-milled to length on a No. 4 Brown & Sharpe milling machine, the length being checked with a limit gage. A Cadillac centering machine is then employed to center both ends, gaging from the opposite side of the large flange in each case.

The next three operations are rough-turning the two sections *A* and *B* at the right of the small flange; rough-turning section *C* and squaring the small flange; and rough-turning end *D*. Each of these operations is performed in a Prentice automatic lathe, a model shaft being used for setting the tools. In machining section *D*, the shaft is not turned down for threading, this end being left one diameter temporarily.

The shafts are then recentered to a uniform depth at each end in a speed lathe, gages being used to check the depth. A Prentice automatic lathe and a model shaft are again used for setting the tools for the next four operations, in which sections *A*, *B*, *E*, *F*, *D*,

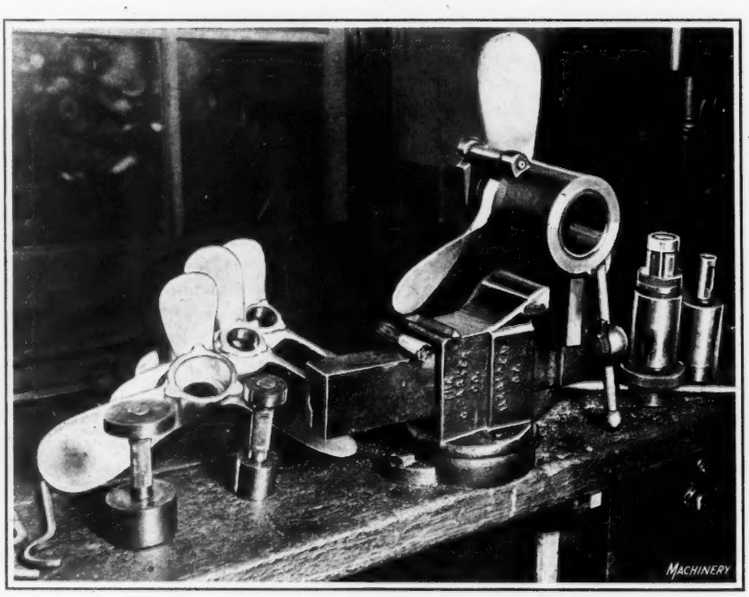


Fig. 15. Equipment used in hand-reaming the Central Holes in the Fan

and the small flange are finish-turned. In finish-turning section *D*, 7/64 inch of stock is left at the end where the one-inch thread is later cut, so that the stock will remain soft after hardening. Both flanges are next underscored in a lathe, the shafts are straightened if necessary, and the keyway is cut for the Woodruff key. The latter operation is performed on a Brown & Sharpe milling machine, a gage being provided for checking the central location. The various holes are then drilled, reamed, countersunk, and tapped as indicated in the illustration, after which the threads in sections *B* and *E* are cut on a Pratt & Whitney thread miller, using 18-pitch hobs and limit thread gages.

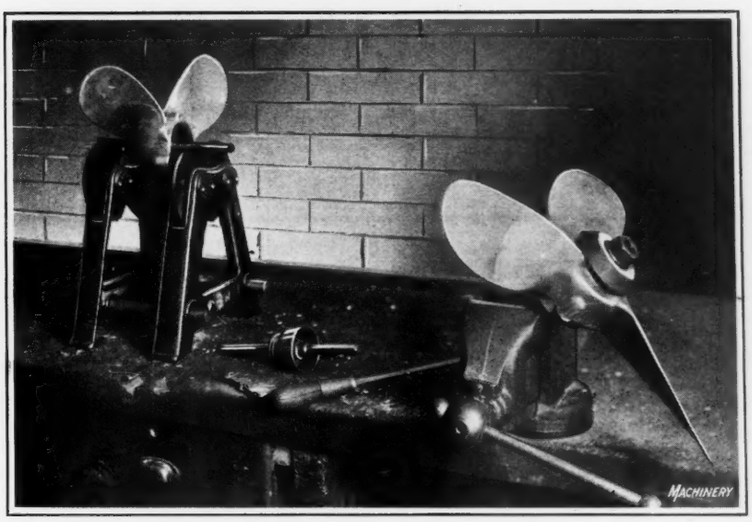


Fig. 16. Bench and Equipment used in producing Static Balance in the Fans

Before heat-treating, the shafts are copper-plated heavily all over, after which the copper is removed from all surfaces except section *A* and the length on section *C* designated by dimension 7.4687 inches—the two surfaces which are not to be hardened. The shafts are then packed in Houghton's "Pearlite" carburizing material at a temperature of from 1650 to 1700 degrees F., which produces a carbon penetration of about 1/32 inch. The shafts are quenched in oil from a temperature of 1580 degrees, and are then reheated to from 1375 to 1385 degrees and quenched in brine. The higher quenching temperature refines the core and the second heat hardens the carburized exterior. The casehardened shafts are next drawn in oil at a temperature of from 350 to 400 degrees F., for a period of from one to one and one-half hours, and are then permitted to cool in the atmosphere.

There are a number of incidental operations performed before grinding, such as cleaning the centers, straightening, wire-brushing section *C*, cleaning the threads and inspecting. The threaded end of section *D* is then ground, underscored, and chamfered, after which it is ready to have the thread cut. The threading operation is performed on a Pratt & Whitney thread miller by hobbing, holding the threads to gage limits. Sections *A*, *F*, and *G*, diameters *B* and *E*, and the inside of the large flange are then rough- and finish-ground. The final operations are grinding the small shoulder to the 3.0625-inch dimension, grinding the shoulder at the small end of the shaft to the specified length, and grinding surface *H* of the large flange to thickness. The dimensions showing the limits to which the various surfaces are machined are given in the illustration.

The fan shaft shown in the lower part of this illustration is finished in much the same manner and with practically the same equipment as the intermediate shaft. The heat-treating is also substantially the same. There is only one operation of which mention need be made, and that is the cutting of the six-threaded left-hand spiral gear, which is done on a No. 3 Barber-Colman hobbing machine having standard equipment.

* * *

A device developed by the Société Anonyme Adolphe Saurer of Arbon, Switzerland, for the purpose of testing the piston-rings of automobiles, was described in detail in a recent number of *Engineering*. The object of this device is to determine whether the pressure exerted on the walls of the cylinder, when the spring is compressed to its working diameter, is within the allowable limits. The device is actually a comparator, as it indicates whether the ring being tested has the same characteristics of stiffness as some standard ring which is known to be satisfactory.

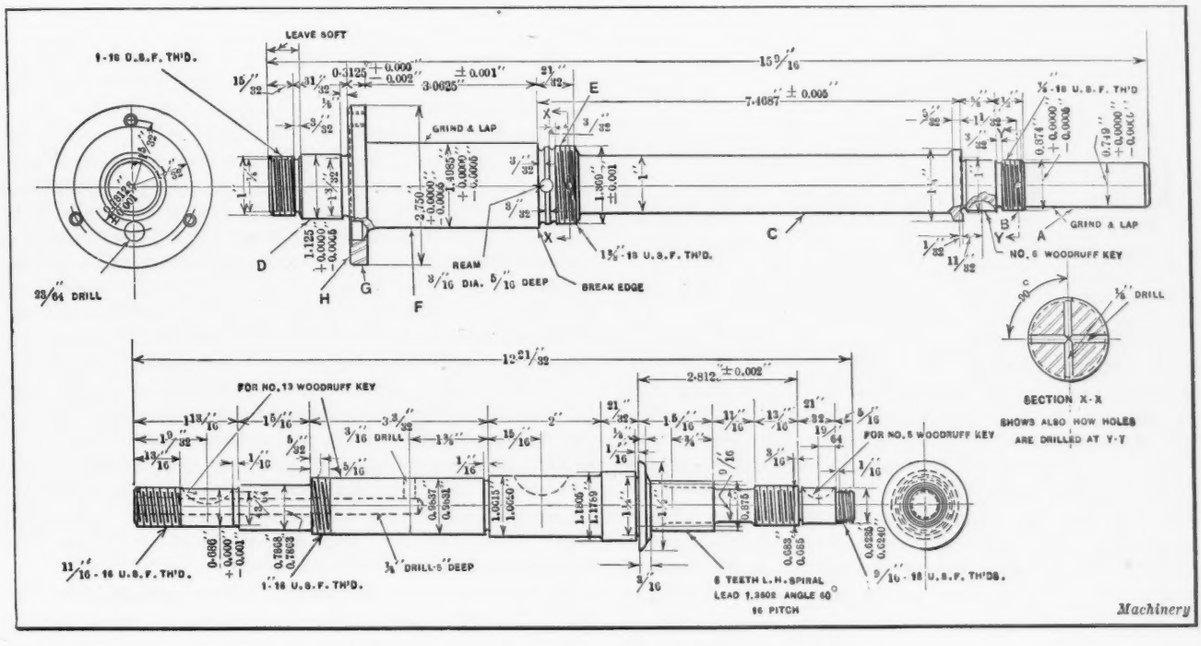


Fig. 17. (Top View) Intermediate Shaft; (Bottom View) Fan Shaft

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THE VALUE OF TRADE STATISTICS

A contributing cause of serious business depressions following periods of great prosperity is the lack of complete and accurate trade statistics which would enable manufacturers to form opinions of the industrial future. If such statistics had been available in 1920 our machine tool manufacturers would have been able to anticipate and prepare for the depression, months earlier than was possible when each had to rely on the information he could obtain individually. Signs of a coming depression in the industry were apparent in the spring of 1920, but most factories were then running full on unfinished orders which assured many that the future was secure; consequently large stocks of material were laid in at high prices and more contracted for. When the depression became a certainty many manufacturers continued to produce for stock, expecting it to be of comparatively short duration. Accurate statistics showing the machine tool production in pre-war years, compared with the production in 1917, 1918 and 1919, would have shown that the industry had produced at such a rapid rate as to make a prolonged falling off in demand inevitable. Apart from their value as records and as a guide to production, trade statistics are helpful to manufacturers in kindred industries whose relation is that of a buyer or seller.

Statistics reveal many surprising and encouraging facts bearing on current conditions. For instance, 85 per cent of the working men and women in the United States are employed today and at higher average wages, when compared with the cost of living, than at any time in the past twenty-five years. Savings bank deposits are increasing today more rapidly than at any time in the history of the nation. These are sure indications of returning prosperity, because apparently we have passed the era of reckless spending and entered upon an era of thrift, which is a necessary adjunct of normal industrial conditions.

Sometime there surely will be available complete trade statistics covering all the important industries, which will make the future safer for manufacturers and investors than it has been. Such statistics must be available to both seller and buyer, so that no unfair advantage can be taken of them for the purpose of limiting production or raising prices. Every industry will be benefited thereby, more stable industrial conditions will be made possible, judgment based on accurate facts will replace guesswork, and manufacturers' associations will exercise their highest functions for the benefit, not of one, but of all the industries of the country. It is becoming more clearly understood that no industry can prosper and profit alone. These conditions in any industry will be possible only when all, or nearly all, are prosperous.

* * *

REPAIR SHOPS NEED BETTER METHODS

In most shops where automobile repairing is done there is no uniformity in methods, and consequently the cost of the work varies greatly. In refinishing cylinders, for example, some shops grind, others ream, others simply bore. If the equipment used for making the same repairs on the same type of engine in a dozen shops could be gathered together, it would make a truly miscellaneous collection. When we consider how highly developed and standardized are the methods of manufacturing automobiles, the crude and inefficient practice in repair shops on the same class of machinery is striking. There are a few well equipped repair shops where the equipment has been selected with a view to efficiency and service and where modern methods are applied; but these are the exception.

Even the service stations maintained by the automobile companies themselves frequently are not equipped or organized to produce the most work for the least outlay, and both equipment and methods seldom compare favorably with those employed in the manufacturing plants where the cars are made. The management apparently does not consider that if the equipment and methods are deficient the service cannot do justice to their cars. The reputation of a high-class car may be lost or impaired through the inefficient service stations maintained by the manufacturers, who should devote the same attention to their service stations as to their manufacturing plants. If the former were brought up to the standard of the factory, automobile repair shops generally would be forced to adopt a higher standard, with resulting benefits to all who use them.

During the past two years considerable new equipment has been installed in repair shops which has not always been bought with the best judgment. Machine tool manufacturers can help this branch of the industry generally by educating small repair shop owners in the selection and operation of the best equipment for their purposes, and all concerned will profit thereby.

* * *

STANDARDIZATION SURELY PAYS

According to the statistics furnished by manufacturers and other authorities in the automotive industry, the annual savings resulting from the standardization effected by the Society of Automotive Engineers amount to 15 per cent of the annual turnover in the industry. This turnover is about $5,000,000,000, and the estimated saving therefrom amounts to $750,000,000 a year. No other society or association that we know of has made such great progress in the practical application of standardization. Hundreds of items have been made the subject of investigation and study, and many of the component parts used in automobile construction are now made by all manufacturers according to definite specifications. The marked improvements made in automobiles, without a proportionate increase in price, have been due in large measure to this work.

Other associations and societies that can do so profitably, should follow the example set by the automotive engineers. What has been accomplished by them can be accomplished in other industries, provided there exists the will to cooperate. This is the most important factor; for the success of standardization work in any industry depends upon the extent to which the cooperative spirit is developed and flourishes. In spite of the strenuous competition between automobile manufacturers there has always been a marked cooperative spirit among them. Individual manufacturers always have given freely their figures on production and turnover to their associations—technical and commercial—and as a result there is more information available relating to the automotive industry than to any other industry except iron and steel. This cooperative spirit is extended to the automobile engineering departments, and through them has come about the standardization work which serves as a bright and shining example to other industries.

Very large savings will result to both manufacturers and users of machine shop equipment and appliances, if through cooperation, manufacturers will agree upon certain standards for such parts of their product as need not differ.

National Machine Tool Builders' Convention

THE spring convention of the National Machine Tool Builders' Association was held at the Hotel Traymore, Atlantic City, April 25 and 26. The main business of the meeting was the revision of the constitution and by-laws of the association, and considerable time was devoted to this question. The remainder of the time was devoted mainly to committee meetings. In addition, reports on standardization were presented and such questions were dealt with as various members themselves chose to bring before the meeting in order to have the present problems of the industry discussed.

Address of the President

In his opening address, the president of the association, August H. Tuechter, of the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, called attention to the solid constructive work that has been done in the face of discouraging conditions, and to the wide recognition that this work has received. Some of the vital problems now confronting the machine tool builders were also reviewed. "When the world again needs new machine tools," said Mr. Tuechter, "we will be there with tools so good that the world will have to throw its old ones on the scrap heap. Perseverance and courage have always marked this industry in every depression, and they mark it now as always before."

One of the important points mentioned was the value of reliable forecasts of fluctuations in demand. "With such forecasts, managers in our industry will be able to avoid disaster by learning to keep their finances sound, by learning when to stock and when not to stock, by learning when to run ahead of demands and when to hold operations close to demand. . . . The industry would also be benefited by having reliable forecasts of revival of demand, so that after costs are reduced through the operation of cyclical forces, the industry can again put men to work in advance of the next rise in demand. All equipment cannot be made for stock, and the builder of non-stock machinery always faces the difficulty of building his forces when the labor market is short of men."

It was pointed out that the work of the association and its cost to members should always be regarded strictly as a business proposition. In this connection, the valuable service rendered by the association when its facilities are utilized was emphasized, and some of the important activities were referred to, such as supplying information on business conditions, taxation, etc., and the issuing of special and periodical bulletins in addition to the monthly survey of economic conditions.

Standardization and statistical work covering every branch of the industry were cited as the two big tasks ahead. The importance of standardization and the backwardness of the machine tool industry in this respect, as compared with the automotive industry, was referred to, as well as the increasing demand for the standardization of those elements that are common to all machine tools. The standardization of T-slots was referred to as the first project to be considered, since these slots are found on practically all machine tools. Reference was made to the work of standardization done by the Machine Tool Builders' Association in England in arriving at a standard for milling machine spindles so that in the future face mills, arbors, etc., can be applied interchangeably to English milling machines.

The General Manager's Report

The customary report by the general manager of the association, Ernest F. DuBrul, contained many matters of great importance to the machine tool builders of the country. Mr. DuBrul particularly emphasized the value of an association as an information bureau, when there is the proper spirit of cooperation and the willingness to spend whatever money is required to get results. Attention was called to the fact that information about an industry must come from the industry, and must then be applied by the individual in his own business. By way of illustrating one of the activities along this line, reference was made to the model contracts covering the taking of patents by employes that were procured and distributed as a safeguard against expensive and unnecessary litigation.

That part of the report covering business conditions referred to the gradual increase in shipments and orders for machine tools since July, and also to the encouraging sign that business policies in the industry are being based, on an increasing scale, upon an intelligent study of the necessary cycles that are characteristic of the machine tool industry.

Another timely subject covered by the report pertained to the valuable service of the association in connection with amortization claims. The claims filed as a result of this campaign are claims for money which the law allows a machine tool builder to deduct or to have refunded, if paid. According to Mr. DuBrul, "The total amount of claims that will be presented and allowed as a result of the association's interest in the matter will far exceed the total cost of the association for the last twenty years and for the coming ten years. This is a direct money benefit that the association has returned to some members."

Interesting features of Secretary Hoover's conference of trade association representatives held on April 12 were summarized, and also such important subjects as the study of unemployment and business cycles, the value of adequate cost systems, and the necessity of improving the statistics of the association, especially those needed for a first-class business barometer.

In connection with cost systems, reference was made to the work started last year and carried to the point of establishing a set of uniform principles which association members may use as a basis for cost-finding systems. "It is very desirable," said Mr. DuBrul, "that those who can possibly afford it, revamp their cost systems to bring them in accord with these principles, and this is the best time to make changes. If members wait until faced with a rush of business, they will be unable to do good revision work on cost systems. Now is the time when members should be using the over-earned and unearned burden accounts that were recommended in our cost plan. The man who divides his total expenditures for a month by the number of hours, or other divisor used to arrive at a burden rate, now gets a ridiculously high figure. Such a method has been described as giving merely an exercise in long division, but not giving costs. If, on the other hand, a concern has established a normal burden rate, its costs continue to be comparable during this sort of period. The difference between a normal rate and the actual expenditure is taken into the unearned burden account."

The proposed business barometer merely deals with orders and shipments and not with production and stocks, as do the various group reports. The sole requisite is that the members furnish the information. The fact was emphasized that in order to get a barometer that is worth while, it is necessary to classify orders and shipments in groups covering all classes of machines according to their prices. Six classes were suggested ranging from $250 and less up to and including $4000. The idea is that such a tabulation of orders monthly, covering all kinds of machines within the given classes, would give the entire industry a valuable index of the progress of demand.

The Trade Association Conference

ANOTHER step was taken toward more complete cooperation between industry and the Department of Commerce at the meeting in Washington, April 12, between Secretary Hoover and the executives and secretaries of trade associations. The meeting had been called to consider ways and means of obtaining closer cooperation between the Department and the industries represented by the trade associations, to plan the organization of a comprehensive statistical service, and to arrange for giving publicity to statistics in such a manner as to meet the requirements of the Department of Justice. The meeting was attended by representatives of several hundred trade associations and by the editors of the leading industrial and trade journals. The opening address by Mr. Hoover defined very clearly the status of trade organizations, the possibilities for cooperation with the Department of Commerce, and the service that trade associations can and should render to their members. A clear indication was also given of the practices of trade associations that are not approved by the Government.

Need for Trade Associations

In his opening remarks, Mr. Hoover emphasized the fact that while the efficiency of individual business men engaged in industry and trade is high, there are many questions of general interest that require common action. This was the reason for the organization of trade and industrial associations. Results valuable to the community have been obtained through this cooperation, but one of our national problems is how to obtain the beneficent results of such cooperation without creating influences that will stifle equality of opportunity. Competition among individuals must be maintained as the main impulse toward progress. The legitimate associations in industry and commerce have proved to be in the public interest; one needs only to examine the many functions of the existing 2000 organizations to demonstrate this.

Valuable Activities of the Trade Associations

Among the activities undertaken by trade associations which have been valuable to the country at large, Mr. Hoover mentioned the promotion of foreign trade, with better preparation of goods to meet the necessities of different markets; the securing of credit information in foreign markets; the collection of information relating to demand and supply of goods from competitive countries, custom regulations, transportation of goods, port and warehouse conditions; and the creation of a merchant marine. In the domestic field they have collected domestic credit information, handled insurance in different forms for their members, and standardized qualities and grades of commodities and products so that the public may obtain reliable grades at predetermined specifications.

They have simplified trade terms, eliminated unnecessary varieties, engaged in joint advertising, acted jointly to prevent infringement in trade marks and designs, promoted welfare work among employes, aided employment insurance, created apprenticeship systems, developed trade education, and acted in common for the prevention of industrial accidents. They have also represented the industries and trades in legislation relating to tariff, taxes, and transportation, and have concerned themselves with freight rates, overseas transportation charges, uniform bills of lading, statistics as to production and stocks of goods, rational cost accounting, etc. All these activities, it would be possible to demonstrate, have resulted in great savings in cost of production and distribution for the benefit of both producer and consumer.

General Membership of Trade Associations

There is one generalization in connection with this movement, Mr. Hoover pointed out, that has been mostly overlooked. The membership of the trade association is predominantly made up of the smaller establishments. Big business can employ its own agents in all these matters. It can establish its grades and standards; it can employ its own research laboratories. Little business can hope only to be equally informed and make equal efforts to promote its welfare through trade associations.

The law provides that the Secretary of Commerce shall promote trade, industry, and transportation. In the reorganization of the Department of Commerce that it might become of far greater real service to our whole public, an effort has been made to cooperate with industrial and commercial organizations in the promotion of marketing abroad, in transportation, in elimination of waste, and in the improvement of our industrial technology, statistical services and information, and in many other directions.

These problems must become practical problems of day-to-day contact with commerce and industry, if the Department is to learn the direction in which real service can be accomplished. Such contact can be secured only through trade and industrial organizations, for without organization there can be no representation. Legitimate trade association work, therefore, Mr. Hoover said, is vital and should be encouraged.

Objectionable Activities of Trade Associations

Mr. Hoover made it very clear that trade associations, in order to obtain the cooperation of the Department of Commerce, must conform with the requirements of the law for maintaining our industries on a competitive basis. Certain doubts have been created as to the right purpose of all trade associations during the past year by the exposure of a few groups that have used the benevolent purposes of trade association work as a cloak to create combinations which restrained trade and became centers of corruption. A canvass of nearly two thousand trade associations has showed that only a small number were engaged in those functions that lay the foundations upon which a restraint of trade is suspected.

It is obvious that the Department of Commerce cannot establish cooperative relations with associations who follow practices that have been condemned by the courts. Again there are some two or three activities carried on by a small number of trade associations, the legality of which has been questioned but not yet determined. These are in the main the so-called "open-price associations," which are collecting data on prices and sales of their individual members, and circulating such individual data again to their members, together with certain other information.

"I wish to state frankly and at once that the officers of the Government do not believe that these functions are in the public interest," said Mr. Hoover "whether they are in violation of the law or not. The Department laid down the rule nearly a year ago that it could not cooperate with associations subject to such criticisms and sees no reason to change it."

Cooperation with the Department of Commerce

In regard to cooperation between trade organizations and the Department of Commerce, Secretary Hoover emphasized that all the services of the Department are offered for voluntary acceptance by the trade associations. They are not imposed upon anyone. The Department wishes no arrange-

ment to be established which is not based on the expressed wish of the industry for such cooperation, with a view to aiding the trade associations in their legitimate intentions to serve the industry.

Many of these cooperative services have been developed by the Department of Commerce during the past year. The foreign trade division of the Department has been divided into specialized branches which work in intimate contact with the men in the different industries, and cooperation has already been established with several trade associations who have appointed special committees to advise and direct the Department's agencies abroad on behalf of the whole industry. This has resulted in placing these energies in the channels where the sale of actual goods has been promoted; in dictating the character of information needed for special trades; and in promoting the economic handling and reduction of risks in foreign business.

This cooperation has been very successful. The growth of inquiries from the industries to this division has increased from a few hundred to several thousand daily. Those industries that have not yet taken advantage of this cooperative effort on the part of the Department are invited to make use of the Department's facilities.

Cooperation with the Bureau of Standards

Another field in which the Department has worked jointly with various trade associations is in the advancement of their efforts at simplification of trade terms, in the simplification of general specifications, and in the simplification of dimensions of many and varied products—all of which make for cheaper production and cheaper distribution, which ultimately benefits the consumer as well as the producer.

The Department of Commerce has cooperated with many different industries in carrying out investigations into the technical processes of manufacture, thus taking advantage of the practical experience of men from the trade associations cooperating with the Department's scientific staff. This work of elimination of waste is of the greatest importance to our commercial and industrial development, and can be accomplished only by cooperative effort on scientific lines.

Value and Need of Statistics

The third field in which the Department of Commerce has had much cooperation has been in the development of the government service devoted to publication of statistics on production and distribution of commodities. These services had existed in the Government for many years and the problem was to make the material of greater value to the commerce of the country. In these matters the Department has had the cooperation of many trade associations. These services need further development in the interest of the whole community.

Statistical information as to productivity and national stocks is needed not only by the men in a particular industry, but by men in other industries as well. A study of the trend of production and consumption does not imply restraint of trade. If it does, then the whole statistical basis of commerce that fills one-third of our newspaper space would need to be abolished, and if it were abolished, we would be bankrupt in ten years. "The matter that I am principally interested in" concluded Mr. Hoover, "is that this information should be available to the whole public. It is the old question as to whether a community will succeed better if it acts in ignorance or if it acts in knowledge."

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A general investigation of scrap losses in aluminum alloy foundry practice made by the Pittsburg Experiment Station of the United States Bureau of Mines showed that the annual losses in the United States amount to about $1,200,000, and that universal adoption of methods recommended by the bureau would probably result in a saving of about $600,000 a year. The complete results of the investigation will be published in bulletin form.

INDUSTRIAL CONDITIONS IN FRANCE

By MACHINERY'S Special Correspondent

Paris, April 13

Industrial conditions in France remain unsettled. Considerable variation from day to day in the exchange rates tends to keep manufacturers from undertaking any contracts covering a lengthy period. The only manufacturing plants operating steadily at the present time are those producing woodworking machinery, or machines and materials to be used in developing the water-power resources in the French mountainous regions. Sales are rare in the machine tool field, except by dealers handling machinery of German manufacture. In the northern part of France manufacturers are entirely replacing the equipment destroyed during the war with machinery imported from Germany. However, certain machines of well-known American make are being purchased by French manufacturers in spite of the high prices. Machinery of English manufacture also has a slight but steady sale.

The Wiesbaden agreement, which at first created considerable adverse criticism among French manufacturers, has now been accepted more or less graciously. At one of its meetings the Federation des Industriels et des Commercants Francais recognized the agreement, holding that the payment by Germany of her indebtedness with manufactured goods was in accordance with the terms of the treaty of Versailles and that it facilitates the actual delivery of the material.

Most of the orders which French manufacturers counted on receiving in connection with the reconstruction of the devastated sections will be placed in Germany. As a result, German industries will occupy an important and definite position in France. The introduction of German goods into France is one of the surest ways of obtaining the proper reparation, if precautions are taken to see that Germany does not send materials that French manufacturers produce in sufficient quantities to meet the needs of the country. It seems that this attitude of mind toward the arrangement is being generally adopted.

During the month of January there was a reduction in the imports of raw materials and manufactured articles which amounted to 836,067,000 francs (about $77,503,400, present exchange) and a reduction in the exports of such merchandise of 127,877,000 francs (about $11,854,200). Present imports are now lower than exports.

A great number of the articles included in the recent tariff laws are insufficiently protected. Since the end of the war a general revision of the tariff rates has been contemplated, but such a revision could not actually be undertaken so long as exchange rates remain unstable and business unsteady. It was, therefore, decided that until such a revision could be made, rates would be based on a system of coefficients. The coefficients established were often arbitrary. Besides being complicated, this system cannot take into consideration the fluctuation and prices of materials. Various propositions on the tariff, including the tariff on machine tools, are now before the Chamber of Deputies.

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TERMS USED FOR CASTINGS

At the American Gear Manufacturers' Association's annual meeting in Buffalo, the metallurgical committee proposed that, in designating castings made from steel, the expression "steel casting" always be used instead of the term "cast steel," in order to prevent confusion with the many so-called cast-steel tool steels on the market. It was also recommended that the term "cast iron" be dropped for the more explicit terms "gray iron" or "white iron" as the case may be, and that the term "semi-steel" be dropped in favor of the more specific term "gray iron with a certain percentage of steel scrap." The association accepted the recommendations with regard to steel castings and gray iron and white iron, but deferred action in regard to semi-steel.

THE RADIO EQUIPMENT INDUSTRY

"Broadcasting" has caused a phenomenal growth of the wireless industry. There are hundreds, if not thousands, of newly formed organizations in the radio field, and many others are constantly being formed to meet the abnormal demand. Most of these concerns, however, are producers in name only. The majority of the so-called manufacturers of radio equipment are little more than assemblers who have no manufacturing facilities. They purchase their metal parts from outside manufacturers, most of whom are unable to fill promptly the orders which are flooding their shops.

The contract shops that are actually doing the manufacturing are not rated as radio equipment manufacturers, while, on the other hand, those assemblers who are so rated often have no factories, or at least none that contain machinery. The entire production facilities in such shops often consist, perhaps, of a bench or two, with a few girls to assemble the units. One electrical engineer who has been connected with radio development since 1905 and is the originator of a certain type of wireless apparatus states that there are not more than twenty actual manufacturers of radio equipment in the United States, who have facilities for producing radio apparatus complete from start to finish. It is the parts manufacturing business that has assumed such large proportions.

Screw machine products molded into some insulating material, or otherwise attached, and sheet-metal stampings constitute the greater part of the metal units that enter into the construction of radio receiving sets. The flood of orders for these metal parts has surpassed the production facilities of shops regularly engaged in the manufacture of this class of work. The overflow will be taken care of by those machine shops that are properly equipped and in a position to handle additional orders. There is an opportunity for metal-working plants having small screw machine and power press equipment available to handle some of the present overflow. The radio industry promises to be active for a considerable period, as there are at present but a comparatively small number of receiving sets in use. It has been recently estimated that about 600,000 receiving sets have been distributed.

Classification of Manufacturers of Radio Equipment

In the early development of any industry there is lack of standardization and efficiency in manufacturing methods. An analysis of the present manufacturing conditions in the radio industry places the manufacturers in three groups: The first class is made up of operating plants that have previously been engaged exclusively in the manufacture of telephone and telegraph equipment. These manufacturers are well equipped for turning out radio apparatus in large quantities, and the methods found in these shops are well systematized. The second class consists of manufacturers who, through a lack of activity in their own industry and because they possess suitable machining equipment, have undertaken to manufacture wireless apparatus and furnish the parts to others engaged in the assembling of the units; manufacturers in this class sometimes build some of the more simple equipment completely. The third group comprises assemblers, who turn out receiving sets, trademark them and place them on the market. It is probable that at present more radio equipment is produced by this means than the combined products of the other two classes.

Machine Tool Equipment Used in Making Radio Apparatus

Molded insulator parts of bakelite, condensite, formica, and other compositions are largely used in radio receiving sets, and glass parts for vacuum tubes and lightning arresters are also extensively used; but neither of these products would be manufactured in a shop primarily engaged in metal-working. For that reason nearly all the molded composition articles are obtained from companies specializing in molded insulator materials; similarly, the glass detector and amplifying tubes and the lightning arresters are generally furnished by manufacturers specializing in those lines.

Comparatively few types of machine tools are employed for making the metal-working parts of radio equipment, fully 75 per cent of the parts being produced on screw machines and power presses. There is considerable use for certain light bench equipment such as bench lathes, and drilling and tapping machines are, of course, required. The hand screw machine or turret lathe also finds considerable use. Although a comparatively large amount of wire is used, most of the winding is done by means of special attachments either on a bench lathe or a speed lathe, so that single-purpose machines are rarely needed.

In the regenerative type of receiving set, the rotor and stator of the variometer are usually made of wood (although these parts are sometimes molded from bakelite), consequently woodworking machines are required for this work. The sets are usually furnished in a wooden cabinet with a suitable panel, made either of wood or of some molded material, on which the controls, dials and connection sockets are arranged. It is not the usual practice, however, for the instrument manufacturers to build their own cabinets, but they often finish the panels, and this requires certain woodworking machines. If the panels are to be grained, a sanding belt is usually employed.

An engraving machine is necessary for cutting the manufacturer's name and all notations pertaining to switches, capacity, and certain other specifications on the panels. A great many of the metal parts are made of nickel-plated brass; therefore plating equipment and polishing machines are in common use. Among the other machine tools that find varied application may be mentioned hand milling machines, nut tappers, arbor and foot presses, power saws, and riveting machines.

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PRODUCTION OF MILLING MACHINES IN 1919

On page 467 of February MACHINERY a table was published giving the production of machine tools in the United States as compiled by the Bureau of Census for 1919. The figures covering milling machines have been corrected by the Bureau because of an error that appeared in the returns given by one of the manufacturers. The corrected figures, as sent by the manufacturer to the Bureau in a revised return, are given in the accompanying table.

MILLING MACHINES MANUFACTURED IN THE UNITED STATES IN 1919

	Number of Establishments	Number of Machines	Value
Milling Machines			
Plain	34	7433	7,088,120
Ohio	10	3246	2,979,301
Wisconsin	3	924	1,536,666
New York	4	646	479,937
Connecticut	3	274	176,986
All other states	14	2343	1,915,230
Universal	17	3201	5,635,758
Wisconsin	4	914	1,710,317
Ohio	4	1155	1,860,215
All other states	9	1132	2,065,226
Vertical	14	1316	2,761,737
Automatic	12	822	1,232,048
Other Types	22	1760	3,000,593

Machinery

* * *

The Soviet Government, about a year ago, placed an order for 1000 locomotives with the Trollhättan Locomotive Works in Sweden, with the stipulation that deliveries be made during a period of five years. The locomotives are of the improved type based on a model developed at one of the leading Russian locomotive works in 1912. During 1921, 50 locomotives were delivered and 200 are scheduled for shipment this year, while during the next three years 250 locomotives will be completed annually until the entire order is filled.

Gear Manufacturers' Annual Meeting

THE sixth annual meeting of the American Gear Manufacturers' Association, held in Buffalo, April 20 to 22, was characterized by the activity always displayed by the association. Many reports on standardization were presented at the meeting, some of which were acted upon and adopted either as standards or as recommended practices. Progress reports were also presented by several committees, although final action was not taken at this meeting. A number of addresses on subjects closely allied to practice in the gear-cutting field were read, the meetings occupying the entire time of the three days set aside for the convention.

The President's Address

In his address at the first general session, F. W. Sinram, president of the association, referred to the present trend in the industry and to some of the important activities of the association. These activities were classified as twofold—commercial and technical. It was pointed out that commercial matters should receive greater consideration, especially as regards concerted constructive effort, and that, regardless of initiative, progress in any direction can be achieved only when a fair proportion of the industry is receptive and ready to cooperate. The discussion of commercial subjects in connection with the association meetings was advocated because "the present demands constructive effort that we may stabilize our industry and do our part in giving stability to business in general." In connection with this topic, the attention of the members was directed to the two group meetings for considering industrial conditions. In view of the fact that there are problems peculiar to each of the main groups comprising the gear industry as a whole, separate meetings for each were arranged to facilitate the deliberations, and in order to accomplish as much as possible. In commenting briefly on the technical side of the association's work, what has been accomplished, especially toward standardization, was referred to as a decided step forward, and as a phase of the work that has attracted the attention of the entire mechanical world.

Papers Read before the Meeting

The papers read before the convention covered a wide range of subjects. H. E. Harris of the Harris Engineering Co., Bridgeport, Conn., read a paper on "Good Practice for Cutting the Faces and Clearance of the Teeth of Hobs, Gear Cutters, and Form Cutters." In this paper Mr. Harris emphasized the necessity for proper rake of hob and gear cutter teeth. Ralph E. Flanders of the Jones & Lamson Machine Co., Springfield, Vt., read a paper on "The Use of the Projection Comparator in Testing Gear and Gear Cutter Teeth," in which he pointed out the advantages of the Hartness comparator for the visual inspection of tooth profiles. G. E. Katzenmeyer, of the R. D. Nuttall Co., Pittsburg, Pa., presented a paper on "The Proportions of Industrial Gears," containing valuable formulas and charts which enable the designer to readily proportion gears according to requirements and to place this work upon a standardized basis. R. S. Drummond of the Gear Grinding Machine Co., Detroit, Mich., dealt with the subject "The Grinding of Gear Teeth and its Future in the Industry." F. E. McMullen and T. M. Durkan presented a paper on "The Gleason Works System of Bevel Gears" in which the principles underlying the system were thoroughly explained.

Hartness Comparator Applied to Gear Testing

The application of the Hartness comparator as a thread-testing apparatus is dealt with in the first part of Mr. Flanders' paper, and then the use of this apparatus for the inspection of gears and gear-cutters is considered. For gear work the comparator is entirely rearranged. The microscope must have a large aperture to take in a whole tooth, and in order to get the required degree of magnification at a distance of five feet (so that the operator can readily observe and manipulate the work) the image is reflected against a mirror, because the angle of projection is so wide that no lens system can be devised to prevent distortion and interference from color bands. The accuracy of the results may be judged from the fact that with a magnification of 100 times, differences of 0.0001 inch can be detected.

As applied to a form cutter, the apparatus is applicable for testing the regularity of the teeth one with another; the tooth of a cutter giving satisfactory results may be compared with one which is not satisfactory and the reasons for the unsatisfactory results determined. The projection of cutter outlines is a comparatively simple problem, owing to the sharp, definite character of the cutting edges. In the case of gears, however, the problem is complicated because of the lack of clearly defined lines both at the entering side of the cut and at the opposite side. Furthermore, many gears used in the automotive field have the teeth chamfered.

An ingenious and interesting part of the apparatus is that used for projecting and tracing a tooth outline representing any section throughout the length of the tooth. This is done accurately and simply, by using a needle that is mounted and focused in the plane of the tooth to be inspected. The tooth outline is traced by this point, the junction of the point and its reflection providing a location for the surface which is measurably accurate within 0.0001 inch; it is also possible to draw the outline rapidly with nearly this degree of accuracy.

Gleason Bevel Gear System

The bevel gear system developed at the Gleason Works, as explained in the paper by McMullen and Durkan, is the result of a need for a definite system of designing bevel gear teeth based on the most desirable tooth form for use under average conditions. It has been common practice in the past to use spur gear formulas, such as those of Brown & Sharpe and Fellows, in figuring bevel gears. These formulas were worked out for an interchangeable spur gear system, which necessarily required some compromise, so that when they are applied to bevel gears, where interchangeability is not a factor, the possibilities of the involute curve are not fully utilized. The Gleason 0.3 and 0.7 long and short addendum tooth was brought out to improve this condition, and various other alterations of the standard spur gear design have been used, but for the most part these can be applied to certain combinations only, and therefore, are not universal. Recent applications of bevel gearing covering a wide range of ratios have made it imperative that a progressive system, embracing all ratios and any number of teeth in common use, be worked out.

An investigation has been conducted by the Gleason Works with the idea of developing a practical system of designing the quietest form of tooth consistent with strength and wear considerations, and the results of this research have been incorporated in a simple table. This system applies to any pair of generated spiral or straight-tooth bevel gears, operating at right angles, where the pinion is the driver and has ten or more teeth. Bevel gears cut on planers of the former type are the subject of a special study, as certain practical limitations prevent the application of the system to this class of gearing without modification.

The principal qualities considered in arriving at this system, arranged in the order of their importance, are

quietness, strength, and durability. In regard to quietness, experience shows that bevel gears cut with a lower pressure angle will operate more quietly than those with a higher one, other conditions being equal. There are several reasons for this: With the lower pressure angle, a greater arc of action is obtained, any eccentricity has less effect, and the radial component of the tooth load is minimized. Thrust forces also make it desirable to avoid the higher angle, not only because of the introduction of an axial or cone thrust not present in spur gears, but also because the majority of bevel gears are overhung from their supports so that the total load should be kept as low as possible. For these reasons the basis of the system is the use of the lowest pressure angle that can be employed without sacrificing strength by introducing excessive under-cut.

The limitation of under-cut has been fixed by a study of successful automobile practice where both strength and silence are paramount. Strength, as governed by the pressure angle, is not sacrificed to any great extent when a low pressure angle is selected in the interests of quietness, because the stronger tooth section of a higher angle is nearly offset by the greater arc of action of the lower angle. The effect of this increased arc of action is to keep the load nearer the pitch line when only one tooth is in contact. Durability has been taken account of in the system by proportioning the teeth so that the sliding action, which is always present in gears, is approximately balanced between approach and recess. The various factors that go to make up the system have been arrived at by an examination of the considerations already outlined, and have been arranged in a simple practical form. The Gleason Works system will be fully described in June MACHINERY.

Reports of Committees

Among the committees that presented reports were the Sectional Committee of the association working in conjunction with the American Engineering Standards Committee; the General Standardization Committee; and the Spur Gear, Bevel Gear, Spiral Gear, Herringbone Gear, Electric Railway and Mine Gear and Pinion, Nomenclature, Worm Gear, Inspection, Composition Gearing, Keyway, Sprocket, Metallurgical, Transmission, Differential Gearing, Tooth Form, Uniform Cost Accounting, and Library Committees.

Companies Elected to Membership

The convention also included two special group meetings, one of the Industrial Gearing Group and one of the Automotive Gearing Group to consider the conditions in the industry. The American Gear Manufacturers Association now has 94 member companies, 110 executive members, and 55 associate members. The Automotive Gear Works, Atlanta, Ga., was elected to membership at this meeting, with C. G. Hamilton as executive member. The Willys-Morrow Co., Elmira, N. Y., was also elected to membership, with F. H. Higgins and T. W. Tidd as executive members. E. H. Ott of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and D. L. Boyle of the General Electric Co., Schenectady, N. Y., were elected associate members.

Executive Committee and Officers

The following members were elected to serve on the executive committee of the association: E. J. Frost, Frost Gear & Forge Co., Jackson, Mich.; J. B. Foote, Foote Bros. Gear & Machine Co., Chicago, Ill.; C. F. Goedke, William Ganschow Co., Chicago, Ill.; W. H. Phillips, R. D. Nuttall Co., Pittsburg, Pa.

The officers were all re-elected to serve for the coming year and are: President, F. W. Sinram, Van Dorn & Dutton Co., Cleveland, Ohio; first vice-president, R. Johnson, Warner Gear Co., Muncie, Ind.; second vice-president, B. F. Waterman, Brown & Sharpe Mfg. Co., Providence, R. I.; secretary and treasurer, F. D. Hamlin, Earle Gear & Machine Co., Philadelphia, Pa.

CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION

The twenty-fourth annual convention of the National Metal Trades Association was held at the Hotel Astor, New York City, April 19 and 20. The first session, in addition to the usual preliminaries, included the appointment of convention committees and the reports of W. W. Coleman, president; Frank C. Caldwell, treasurer; Homer D. Sayre, commissioner; and L. W. Fischer, secretary. During the sessions following, many subjects of vital importance to the metal trades were presented by prominent speakers. Professor Harold G. Moulton of the University of Chicago spoke on "American Industry and the Stabilization of Europe." A clear analysis of the factors affecting business conditions both here and abroad was presented, as well as the important points to be considered in building up export trade. "Facts and Fancies about Wages in Basic American Industries" was the subject of an address by Magnus W. Alexander, managing director of the National Industrial Conference Board, New York City. A. M. Loomis, from the Washington office of the National Grange, spoke on "The Farmer as a Balance Wheel"; and James A. Emery, counsel for the National Association of Manufacturers, spoke on "Industrial Courts." E. L. Greever, whose subject was "West Virginia Fights for Freedom" gave first-hand information on this critical situation, Mr. Greever having been counsel for the non-union mine operators.

Report of Apprenticeship Committee

Another subject of vital importance to the metal trades, which was discussed at the convention, was that of training apprentices to be skilled all-around workmen. The committee on apprenticeship examined various apprenticeship systems in order to incorporate their virtues and eliminate their defects in the training course advocated. The report which the committee presented laid down courses of shop work of the apprentice and included suggestions for a standard diploma, for an interchange of apprentices among the smaller or specialty shops, and dealt with other aspects of the apprenticeship problem on the basis of the best American practice. Harold C. Smith, chairman of the Industrial Training Committee is president of the Illinois Tool Works and also of the Chicago branch of the National Metal Trades Association. The other members of the committee are William Taylor, president of the Chandler & Taylor Co., of Indianapolis, and John C. Spence, works manager of the Grinding Machine Division of the Norton Co.

The officers of the association for the coming year are as follows: President, W. W. Coleman, Bucyrus Co., South Milwaukee, Wis.; first vice-president, J. B. Doan, American Tool Works Co., Cincinnati; second vice-president, Paul C. DeWolf, Brown & Sharpe Mfg. Co., Providence; treasurer, J. W. O'Leary, Arthur J. O'Leary & Son Co., Chicago; commissioner, Homer D. Sayre; and secretary, L. W. Fischer.

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MEETING OF AMERICAN WELDING SOCIETY

The American Welding Society held its annual meeting in the Engineering Societies Bldg., New York, on April 26 to 29. At the morning session on April 26 there was a conference, at which a number of tank manufacturers were present, for the purpose of considering the subject of the welding of unfired pressure vessels. At the technical session, held on the evening of April 27, a number of interesting papers were presented, among which were "Welding of Heavy Copper Plate," by A. S. Kinsey; "Electric Welding of Dredge Pipes," by J. H. Nead and R. L. Kenyon; and "Thermit Welding," by J. H. Deppeler. The reports of the various committees were presented at the different sessions, covering welding wire specifications, resistance welding, specifications for steel to be welded, electric arc welding, gas welding, training of operators, and welding of storage tanks.

Tool Design Standards

Development of Standard Instruction Sheets for the Use of Tool Designers

By H. P. LOSELY, Industrial Engineer, Detroit, Mich.

ANYONE who has worked in different tool designing offices must have noticed the large amount of time usually spent in looking up machine dimensions, how other jigs or fixtures are made, and other miscellaneous information. Somewhat less obvious, but none the less substantial, is the amount of time spent in designing certain elements of tools again and again which could be worked out carefully once, and after that simply copied when required. In addition, extra time is taken in checking the drawings each time to see that all parts of the design are correct. It is the purpose of this article to show how the principle of permanent standard practice instructions may be profitably applied to tool designing.

Developing Standard Practice Instructions

The first thing to be considered in developing such standard instructions is what shall be covered by them. No hard-and-fast rule can be laid down to cover all cases, but the following will serve as a general guide:

1. General instructions should be issued on office practice, covering every phase of the work, including the organization of the office and its relation to other departments, and the methods to be followed in ordering and routing work. The practice to be followed in making designs and drawings should also be written down. When a new man comes into the organization, he can read over these instructions and readily acquaint himself with customs, so that he can work in harmony with the organization.

2. Data should be accumulated of all machines on which jigs and fixtures are employed.

3. All elements of construction which recur with great frequency in jigs and fixtures, such as spring plungers, U-lugs, eyebolts, etc., should be carefully studied, and standard practice instructions issued concerning them. In many cases it will be found practical to draw up the element in question to scale, and dimension it so that when it is required in a design it can be readily copied. Not only does this save time otherwise spent in designing that element, but it also enables the designer, in making the first lay-out, to know how much space he will need for the element. Furthermore, the completed design will be known to be correct.

4. Certain detail parts can be so drawn on standard instruction sheets that special drawings will be unnecessary in the making of tooling equipment. This does not mean that the parts must be carried in stock; they may be catalogued by a classification number and ordered by that number when required. Examples of detail parts that can be handled in this way are as follows: Drill bushings, tool bits, locating keys and pins, jig feet, adapter plugs, and gage handles.

5. There are many details such as hand-knobs, handwheels, stops for jig lids, baseplates, angle-plates, and handles, which vary in the dimensions required on an individual tool, but which can readily be made from a standard pattern. This method reduces pattern costs as well as the time required to obtain the casting. In many cases it may be feasible to keep rough castings in stock, thus still further reducing costs.

In making up standard practice instructions, the neatest and handiest arrangement is to use one size of sheet. A size that has given satisfaction is 8½ by 11 inches, leaving at least a ¾-inch margin at the left side so that holes may be punched for placing the sheets in a three-ring loose-leaf binder or so that they may be bound together. When only a few copies of the instructions are required, they may be typed with a black ribbon on a good bond paper, preferably without a watermark. Black carbon paper should be placed with the carbon side to the back of the sheet thus producing a negative from which blueprints may be made. If many copies of the instructions are needed, some manifolding process may be employed. In larger offices it is worth while to have blank sheets printed and carried in stock ready for use.

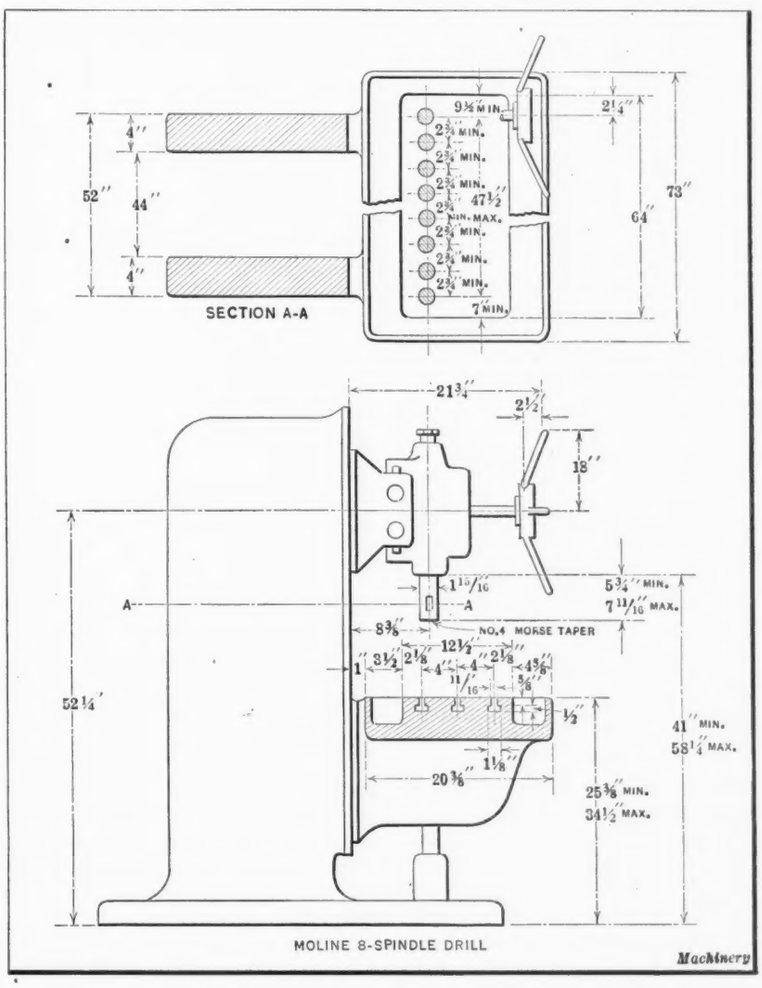


Fig. 1. Standard Data Sheet containing Information Relative to a Drilling Machine

Collection of Machine Data

The subject of machine data is somewhat controversial. In the opinion of the writer it is not worth while, as a rule, to make elaborate drawings of each machine; whenever data is required it should be obtained and arranged conveniently for reference. This end may be attained by not allowing any draftsman to go into the shop to sketch a machine without permisson from the chief draftsman who has charge of the standards. This scheme makes the men use the sheets in existence, and whenever any material is at fault or missing, they must bring the matter to the attention of the chief draftsman. The latter can keep notes of such work and see that data obtained are turned in to him. A sketch can then be drawn on a standard sheet, and the latter can then be indexed and placed in the file.

When work is slack and it is desirable to keep the force together, it may be a good thing to have sketches of all machines drawn up. The data for a machine much used may, of course, be worked up elaborately, and an ink tracing made. In any case, all dimensions should be checked by a second man before a sheet is put in the reference file. Fig. 1 gives an idea of the manner in which useful data of a machine may be arranged. In drawing up standards for units, parts, or patterns, there will be a choice between tabulating and showing each size drawn to scale. If the space is limited so that tabulation is necessary, care should be taken to do this with due regard to proportion. In fact, it is generally advisable to sketch each size roughly to scale before tabulating dimensions in order to be sure that no errors are made. It is preferable to draw each size separately on data sheets, as it eliminates referring to a tabulation for dimensions and in many cases allows a designer to make a direct comparison between sizes, enabling him to decide readily which size is best for the work in hand.

Indexing and Cataloguing Instruction Sheets

It is most important that a proper indexing and cataloguing system be used in connection with instruction sheets. One of the chief reasons that unsatisfactory results are sometimes obtained in making up standards is that they are incompletely indexed and badly kept so that when information is wanted it cannot be found. Considerable forethought is necessary in deciding upon any numbering system, since if it is done haphazardly, a renumbering may soon be required, causing great annoyance and some expense. Before deciding on a system, it is advisable to ascertain what other numbering systems are being used by the concern so that the one used for standard sheets and parts will not be confused with others. The writer uses a symbol consisting of a letter indicating the class of data, a prefix number indicating a group in that class, and a suffix number for each sheet of the group.

Suppose, for instance, a sketch is made of a Whitney No. 6 hand milling machine. The letter "M" may be used for all machine tool data, and upon referring to the classification list in Table 1, it will be seen that 12 is the group number. Looking under the detailed list of sheets it might be found that two other hand milling machine sheets had been previously issued so the number assigned to the new sheet would be 12-M-3. Then, if a draftsman requires data on this machine he can find it on the list of hand milling machines and get the sheet from the supply room.

TABLE 1. INDEX TO MACHINE TOOL DATA SHEETS

General Classification

Group No.	Type of Machine
1- 9	Drilling and tapping machines
10-19	Milling machines
20-29	Lathes and screw machines
30-39	Grinders
40-49	Shapers, planers, and slotters
50-59	Boring machines
60-69	Punching machines
70-79	Gear-cutting, thread-milling, profiling and broaching machines
80-89	Bench equipment
90-99	Miscellaneous

Note: For automatic and semi-automatic machines, see Section A

Detailed Classification

Group No.	Type of Machine
1	Upright drilling machines
2	Radial drilling machines
3	Multiple-spindle drilling machines
4	Bench drilling machines
5	Electric drills (hand)
6	Gun drills
7	Tapping machines
10	Plain milling machines
11	Universal milling machines
12	Hand milling machines
13	Vertical milling machines
14	Multiple-head milling machines
15	Lincoln milling machines
16	Briggs milling machines
17	Automatic milling machines
18	Keyway milling machines
20	Engine lathes
21	Turret lathes
22	Bench lathes
23	Centering machines
30	Plain cylindrical grinders
31	Universal grinders
32	Surface grinders
33	Internal grinders
34	Cylindrical grinders
35	Disk grinders
36	Cutter grinders
37	Portable grinders
40	Shapers
41	Planers
42	Slotting machines
50	Vertical boring mills
51	Horizontal boring mills
60	Plain power presses
61	Back-geared presses
62	Toggle presses
63	Foot presses
70	Gear-cutting machines
71	Thread milling machines
72	Profiling machines
73	Broaching machines
80	Arbor presses
81	Bench straighteners
82	Vises
90	Shears
91	Saws
92	Furnaces
99	Special machines

Machinery

In numbering special tools the part number method may be used, in which a symbol is added to the part number consisting of a letter which designates the kind of tool and a distinguishing number. Then when two fixtures are required for part No. 529, for example, they are numbered 529-F-1 and 529-F-2.

Various letters may also be used for identifying the standard sheets. The letters used for these purposes must receive consideration when making the standard sheets, and the following arrangement is suggested:

SPECIAL TOOLS

(B) Boring and reamer bars
(C) Cutters
(D) Punches and dies
(F) Fixtures
(G) Gages (special)
(H) Multiple heads
(K) Tool-blocks
(L) Arbors
(R) Reamers
(T) Tool bits
(Y) Special machines
(Z) Form tools

STANDARD SHEETS

(A) Automatic lathe data
(E) Construction elements for general use
(M) Machine tool data
(N) Small tool and equipment data
(O) Organization and office system
(P) Pattern drawings
(Q) Gages (standard)
(S) Stock lists
(V) Thread gages (s't'd.)

The reason for subdividing the standard data sheets into nine classes is that this allows the group numbers generally to be kept down to two digits, and should a renumbering of any class become necessary, probably only that one class would be affected. Table 1, to which reference has previously been made, shows an index for data on machines generally used in a large shop, and indicates how the various groups may be arranged.

Accessibility and Maintenance of Data

In the distribution of standard data, the two main requirements are to make the information accessible and to

keep it up to date. The following suggestions may be of value in securing these ends:

1. Place the responsibility of upkeep on the chief draftsman who can appoint an assistant if necessary.

2. File all original data sheets in the supply-room drawing files.

3. Keep a visible card index of all data sheets in an accessible place so that anyone can find the number of any required sheet.

4. Have the supply clerk maintain a separate file of blueprints of the standard sheets. The number of copies in existence should be recorded on the left-hand margin of the original, or in a large establishment, a separate card index may be kept for this purpose.

5. Require a receipt for each blueprint lent, this receipt to be given back only when the blueprint is returned to the file.

6. When changes or additions are made, require the chief draftsman to obtain the original and all blueprints from the supply clerk and have them all changed together, or the old prints destroyed and replaced by new ones.

7. Select sheets which are frequently required, and make up special standard books. These books should be firmly bound, properly recorded, and charged to the men receiving the books; loose-leaf binders should not be used.

8. Keep complete sets of prints for open reference, in small shops; where more than four men use a set, it is difficult to maintain them in this way, and it is better to keep them in a file room.

Standard Feet for Jigs and Fixtures

As a rule, it is preferable to make a jig or fixture with feet, rather than to have the under side of the base machined all over. This is particularly so when a jig is to be slid around and turned on the machine table, as it lessens the chance of chips getting between the jig and table contact surfaces. Incidentally, the cost of machining and scraping the feet is less than when a solid base is used. If a fixture is clamped to the table or not pushed around much, the most economical design is to make the feet integral with the fixture casting. The feet should be located in such a way as to prevent distortion of the casting by clamping or cutting strains, and they must be far enough apart to prevent rocking or upsetting of the fixture. Fig. 2 shows a fixture used in drilling a hole in a long bar; the bar is supported by a button *A* close to the drilling point, and an extra foot *B* is placed beneath this point of pressure to prevent the whole casting from sagging. This makes it possible to use a lighter design than could otherwise be employed.

Where cast feet are in the form of pads, they should be 1-inch square, and when finished there should be a ¼-inch clearance between the table and the rough surface of the base. If the feet are formed by an extension of a wall, they will naturally be made the same thickness as the wall and should generally be not less than 1½ inches long. The practice with milling machine fixtures is usually to make a solid base; however, if the base is over 8 by 10 inches, it is advisable to relieve it, but care must be taken to see that all pressures are transmitted directly to the machine table.

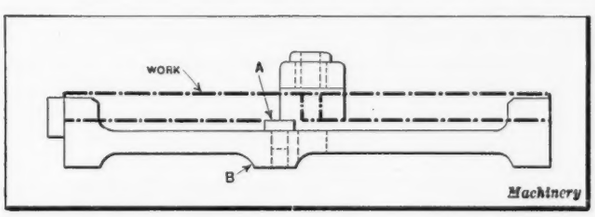


Fig. 2. Drill Jig with Extra Foot located close to Drilling Point to prevent Distortion

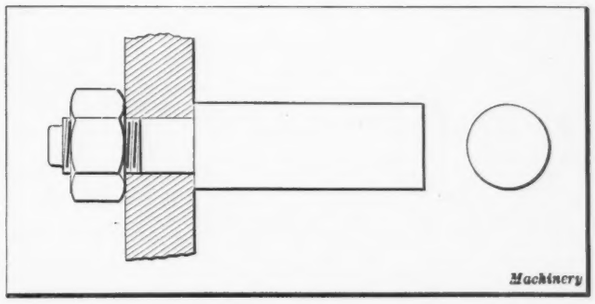
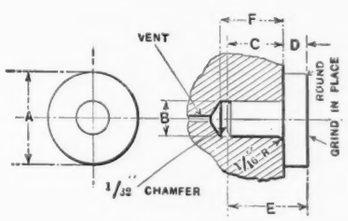


Fig. 3. Type of Foot commonly used on Reversible Jigs

When a jig is to be slid around, or if great accuracy is required, it is best to use inserted hardened tool-steel feet. These can be carried in stock by the tool-room in sizes such as shown in Table 2, of which the 1-inch size is best adapted for general use. These stock feet are pressed fits in standard reamed holes, and the working surface of each foot is ground after all the feet of a jig have been assembled. As with any pressed-fit plug, an air vent must be provided and provision made for removal. If the air vent is so placed that a pin cannot be used to drive out a foot, then the pad supplied for the foot on the casting should be smaller in diameter than the large diameter of the foot, so that the latter may be pried out. Fig. 3 illustrates the type of foot construction commonly used on reversible fixtures, both ends of the plug being ground.

TABLE 2. DIMENSIONS OF STANDARD INSERTED JIG AND FIXTURE FEET



All dimensions in inches

A	B	C	D	E	F
¾	0.3758 0.3755	⅝	¼	⅞	¾
1	0.3758 0.3755	⅝	¼	⅞	¾
1¼	0.5010 0.5005	¾	5/16	1 1/16	⅞

Machinery

* * *

COMPENSATION FOR SKILLED WORK

By CHARLES W. LEE

The kind of encouragement often accorded skilled mechanics, especially in small towns, is well illustrated by the following incident. A hurry call on the 'phone was received recently from a neighboring manufacturer requesting the writer to come and see if he could tell what was the matter with one of the machines. The writer, not wishing to be unneighborly, left what eventually proved to be far more important business to comply with the request. On arriving at the plant a whole group of machines was found idle. Something had gone wrong with one of the machines, causing the production of the entire group to be suspended. In spite of all efforts, no one had been able to locate the trouble.

The matter was soon straightened out however, and production resumed. The writer began mentally to convert about $24.99 into terms of gasoline, supposing of course, that the manufacturer would at least suggest that a bill be sent in for the service rendered. But instead, he looked at his watch, and said: "Now let's see—you've been here about half an hour, would fifty cents be about right?"

Cutting Spur Gears by Hobbing

Setting up Gear-hobbing Machines—Examples from Practice—Application of Multiple-threaded Hobs—Cutting Small Pinions

Fourth Article of a Series on the Use of Different Types of Gear-cutting Machines for Cutting Various Classes of Gearing

GEAR teeth cut by the hobbing process are given the required shape or curvature by a generating action resulting from the rotation of the gear blank relative to a cutter of the hob form. Gear-hobbing machines are commonly applied to the cutting of spur, helical, and worm gearing, and hobbing is the most rapid method of cutting gears by a generating process. This article will be confined to spur gears.

In the practical application of the generating principle to gear-hobbing machines, the hob used has cutting teeth of the same cross-sectional shape as teeth of a rack of corresponding pitch, except for minor variations such, for example, as increasing the length of the hob teeth to provide for clearance at the bottom of the tooth spaces. As the hob teeth lie along a helical path (like a screw thread) the hob is set at an angle to align the teeth on the cutting side with the axis of the gear blank. When the hob is inclined an amount depending upon the helix angle of its teeth, the latter represent a rack on the cutting side.

When a hobbing machine is in operation, the gear blank and hob revolve together, the ratio depending upon the number of teeth in the gear and the number of threads on the hob—that is, whether the hob has a single or a multiple thread. This rotation of the hob causes successive teeth to occupy positions corresponding to the teeth of a rack, assuming that the latter were in mesh with the revolving gear and moving tangentially. In conjunction with the rotary movement of the hob, the slide on which it is carried is given a feeding movement parallel to the axis of the gear blank. As this feeding movement continues across the gear blank (or blanks when several are cut together) all of the gear teeth are completely formed. In other words, hobbing is a continuous operation, since the teeth around the entire circumference of the gear are finished together (instead of one tooth being cut at a time) and ordinarily by one passage of the hob.

A front view of an Adams-Farwell gear hobber, built by the Adams Co., Dubuque, Iowa, is shown in Fig. 1. The slide carrying the hob-spindle feeds downward or vertically as on most gear-hobbing machines. As the illustration shows, the gear on this machine is about half finished. It is made of cast iron, has 90 teeth of 3 diametral pitch, and a 3¼-inch face width. A particularly smooth finish was obtained by using a feed of 0.050 inch per gear revolution, and a hob speed of 80 revolutions per minute. This gear was completed in one hour and twenty minutes.

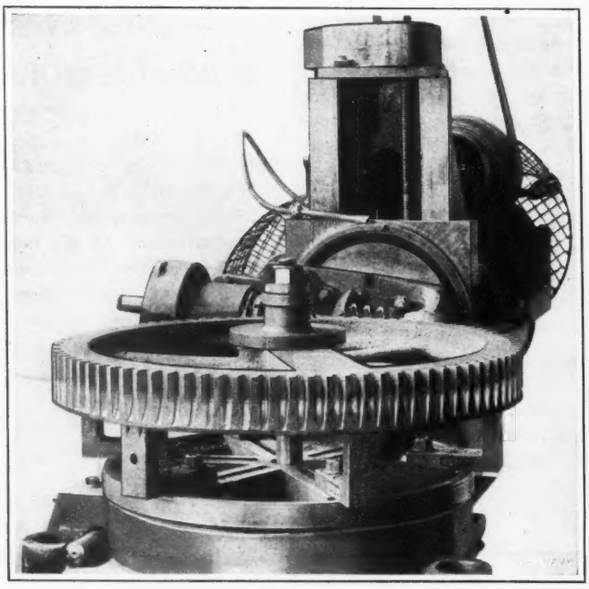


Fig. 1. Hobbing a 90-tooth Spur Gear of 3 Diametral Pitch

Another Adams-Farwell machine is shown in Fig. 2. In this instance five gears were clamped in a stack on the work-table, and were cut at one passage of the hob. This is common practice when the shape of the gear blanks will permit placing one on the other. The operation is roughing differential ring gears for a tractor. These gears have 100 teeth of 4 diametral pitch, and a 2¼-inch face width.

The hobbing machine or generator shown in Fig. 3 differs entirely in its design from the vertical-cutting type of machine. The head or slide which supports the hob is adjusted along the bed to suit the diameters of the gears to be cut, but remains in one position when the machine is in operation. The feeding movement is in a horizontal direction and is applied to the slide carrying the work. This illustration shows a 19-inch generator, made by the Lees-Bradner Co., Cleveland, Ohio, arranged for cutting tractor gears.

The gear-hobbing machine shown in Fig. 4 is so designed that the slide carrying the hob is mounted on the horizontal ways of the machine bed, and the horizontal work-spindle is supported by a slide adjustable along the vertical face of the column, to suit the diameter of the work. This machine is made by the Barber-Colman Co., Rockford, Ill., and in the illustration it is shown cutting a stack of six gears, having 37 teeth of 5–7 pitch.

The hobbing process is used extensively for cutting helical as well as spur gears, and its application to the former will be considered in a succeeding article. Hobbing machines are also used for cutting worm-gears and even for cutting worm threads.

Setting up Machine for Hobbing Spur Gears

While the exact method of adjusting or setting up a gear-hobbing machine varies somewhat with different designs and makes, there are certain general adjustments common to different machines.

No attempt will be made to cover the details of various designs, the idea being to deal with the more important general features.

In arranging a machine for cutting spur gears, there are several important adjustments to be made. The hob must be set to the correct angle, and an axial adjustment for centering a tooth relative to the gear blank may be considered desirable. The machine must be so geared that the hob and work revolve at the proper speed ratio. This is taken care of by means of change-gears.

The rate at which the hob feeds across the gear blank must be varied to suit the quality of finish required on the teeth and the cutting qualities of the material. Change-gears in some form, are also used for this purpose. This feeding movement, as previously mentioned, is parallel to the axis of the gear being cut, and the amount per revolution of the gear blank or work-table may vary from 0.015 to 0.030 inch on some jobs and from 0.100 to 0.200 on others.

The method of holding or chucking the gear blank (or blanks) is very important, and there are two essential points to consider: First, the blanks must be supported rigidly to prevent any decided springing action when the hob is at work; second, the gear blanks must be concentric with the axis of the work-spindle or table and not be sprung out of shape by clamping. It is well to test the concentricity of the blanks after they are placed on the machine and before cutting, by the use of a dial indicator.

The next step is to adjust the blank relative to the cutter, or vice versa, so that gear teeth of the correct depth will be cut. This may be done on most machines, by adjusting the cutter-slide until the hob is opposite the uncut blank; then the work-table is moved until the teeth of the hob, which should be revolving, just graze the blank. The hob is next moved far enough to clear the rim of the blank, and the work-slide is adjusted toward the hob an amount equal to the whole depth of the tooth. Gear hobbers have graduated dials on the feed-screws or special gaging devices to facilitate making these adjustments. When the hob is set for the depth of cut, as just described, the teeth should be correct provided the outside diameter of the gear blank is the right size.

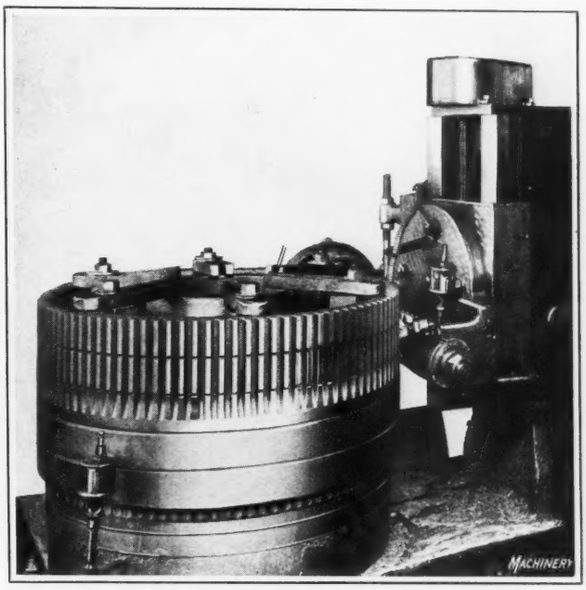


Fig. 2. Hobbing a Stack of Five Spur Gears

A reliable method of checking the accuracy of the teeth is to measure the chordal thickness, using a vernier gear tooth caliper. This chordal thickness should be checked just as soon as the hob has been fed into the gear blank far enough to produce completely formed teeth. Before the cut is started, the work-holding table or slide should be secured rigidly to the ways on which it is mounted, by means of clamping screws provided for this purpose.

The stop which serves either to automatically disengage the feed or stop the entire machine after the gear teeth are cut, is set before starting the machine, so that it will come into action after the center of the hob clears the edge of the gear blank. Spur gears are usually finished at one passage of the hob, although sometimes a roughing cut is taken with the hob set slightly less than full depth, and this is followed by a finishing cut in order to obtain greater refinement. According to one rule, two cuts should be taken when cutting gears of 3 diametral pitch and coarser, assuming that gears of the best grade are required. The important adjustments referred to briefly in the foregoing will now be dealt with more completely.

Determining Angular Position of Hob when Cutting Spur Gears

Although a hob must conform to the diametral pitch and pressure angle of the gear to be cut (the pitch being stamped on the hob), it is not necessary to consider the number of teeth in the gear, as when using formed cutters. In other words, a hob of given pitch is applicable to gears having any number of teeth, and this is also true of cutters used on any machine of the molding-generating type.

The angle at which the hob-spindle or swivel slide is set depends upon the lead of the hob thread and its diameter, since the object of inclining the hob is to bring the teeth on the cutting side into alignment with the axis of the gear blank. This angle is equal to the helix angle of the hob thread at the pitch line, measured from a plane perpendicular to the hob axis, and is often called the "end angle." To avoid the necessity of making calculations, this angle is usually stamped on the hob. If the angle is not known, its tangent may be determined simply by dividing the lead of the hob thread by the pitch circumference.

Gears may be cut with left-hand hobs, although hobs threaded right-hand are used ordinarily. The hob is inclined from the horizontal position in one direction when it is right-hand, and in the opposite direction when it is left-hand. The proper direction may be determined readily by simply considering which way it is necessary to turn the swivel slide, to bring the teeth on the cutting side parallel with the work-spindle.

Centering the Hob

In many shops it is the general practice to locate one tooth of the hob central in relation to the gear blank before setting the hob at the required angle; that is, the hob is adjusted in a lengthwise direction until the center of one tooth lies in the same plane as the axis of the gear blank. The object of centering a tooth is to avoid slight errors which are sometimes caused by using a hob that is not centered, and to insure that the teeth will be cut the full depth.

The effect of hob-centering was analyzed in an article by John Edgar, published in June, 1914, MACHINERY, page 862. It was pointed out that there are hob defects that cannot be compensated for by centering, such as distortion due to hardening and unequal tooth thickness due to springing of the tool when forming. The defect that centering favors is that of any slight eccentricity which causes the teeth to run out of true, as when the arbor is not concentric with the spindle; the inaccuracy resulting from the use of an untrue arbor when backing off the teeth may be another cause of eccentricity.

The three conditions considered included (1) a hob with the low tooth and high space centered; (2) a hob with the high tooth and low space centered; (3) a hob not centered but half way between the conditions represented by the two preceding cases. Mr. Edgar's general conclusions are as follows: With an unground hob in which the eccentricity is an unknown quantity, but may be taken as sure to be existent, it is well to center the high tooth; and with an accurate hob, such as would be obtained by an accurate method of grinding, it is unnecessary to center the hob, if

the hob has been carefully sharpened and the hob arbor runs true on its axis.

According to Gould & Eberhardt, it is important to center a hob tooth when cutting gears having less than thirty teeth. The centering gage on the Gould & Eberhardt machines is permanently attached to the slide at the rear of the hob. The hob is adjusted until the gage, which may be moved forward by turning a small knurled knob, coincides with a tooth space on the rear side; then a tooth at the front side is in a central position, as the hobs have an even number of flutes. The hob is adjusted lengthwise for centering by loosening nuts on the spindle bearings, which permits adjusting the bearings in a lengthwise direction by means of a small screw. When a tooth space matches the gage, the spindle bearing bolts are tightened and the gage withdrawn.

According to the Newark Gear Cutting Machine Co., the subject of hob-centering may be summarized as follows:

1. For roughing operations, where the prime object is the removal of metal, without especial regard to the accuracy of the tooth contour, the centering of a hob tooth is not necessary.

2. The best gear shops today commonly use ground hobs for finishing the better grades of gears, so they are not concerned with the errors due to distortion in hardening. It is not possible to get the best production if the hob arbor runs out of true or if the hob has a high tooth, as either of these conditions causes a few teeth to do all the work, which makes them become dull very rapidly.

3. If hobs were made with a vast number of teeth, centering a tooth would be unnecessary. Since hobs are made with from about four to twenty flutes, or rows of cutting teeth, it will be seen that the gear tooth contour is composed of a large number of small flats produced by the hob teeth. To illustrate, if a gear tooth were found with a contour made up of only six flats which did not match each other on the two sides of the tooth, the tooth would be unsymmetrical. This would be an extreme case, as a gear tooth contour should be composed of from fourteen to twenty flats or more.

4. A hob should be centered when it is found that unsymmetrical gear teeth are being cut. If centering does not correct this fault, the trouble is in the hob teeth or the machine itself. To prevent unsymmetrical tooth contours, a hob tooth should be centered if the hob has less than twelve flutes, especially when hobbing gears of less than thirty teeth, for extra fine work, or eighteen teeth for ordinary work.

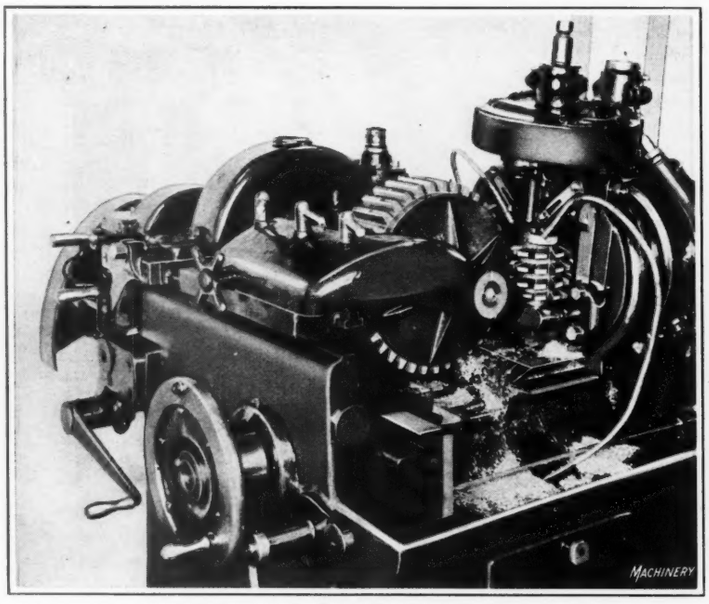


Fig. 3. Cutting Tractor Gears on Hobbing Machine having Horizontal Work-spindle

Adjustment of Hob to Distribute Wear

In order to distribute wear, it is good practice to set different teeth in the central position when resetting the hob. A hobbing machine has been designed to give the hob an axial movement in conjunction with the required feeding movement, the idea being to insure a more uniform distribution of wear. To compensate for this lengthwise motion of the hob, the rotary speed of the gear blank differs from the normal speed required when a hob remains in the same axial position. This change in the rotation of the work is just enough to compensate for the lengthwise motion of the hob. This refinement makes the machine more complicated, and such a design is not likely to supersede a simpler one, especially in view of the fact that wear on the hob teeth can be distributed satisfactorily if care is taken to set the hob each time so that different parts are in the cutting position.

Rotating Hob and Gear Blank at Correct Speed Ratio

When cutting spur gears with a single-threaded hob, which is the kind generally used, the number of revolutions made by the hob per revolution of the gear is equal to the number of teeth to be cut. For example, if a gear is to have forty teeth, the machine would be geared to revolve the hob forty times during one revolution of the gear or work-table. The combination of gears required for cutting any gear would ordinarily be determined simply by referring to a table or chart accompanying the machine.

When calculating these gears, it is necessary to consider the fact that in all gear-hobbing machines there are certain gears that form a permanent part of the machine and serve to transmit motion from the main driving shaft to the hob-spindle and to the work-table. Since the ratios of these permanent gears vary in machines of different makes, these ratios enter into change-gear calculations: In the equation given below, which may be used to calculate change-gears on machines of different makes, there is a constant or fixed value for each machine. These fixed numbers are based on the ratio of the permanent gearing in each machine, and serve to allow for this ratio. In the equation n equals the number of threads on hob (that is, n equals 1 for a single-threaded hob, 2 for a double-threaded hob, etc.), N equals number of teeth to be cut in gear, and the constants for different machines are: Adams-Farwell, 30; Barber-Colman, 30; Gould & Eberhardt, 60; Lees-Bradner, 24 on some machines, 32 on others; Newark Gear Cutting Machine Co., 16, except for special machines.

$$\frac{\text{Product of No. of Teeth in Driving Gears}}{\text{Product of No. of Teeth in Driven Gears}} = \frac{\text{Constant} \times n}{N}$$

To illustrate how change-gears are calculated, assume as an example that the gears to be hobbed have 45 teeth, a single-threaded hob is to be used, and the constant of the machine is 60.

Then

$$\frac{\text{Product of Driving Gears}}{\text{Product of Driven Gears}} = \frac{60 \times 1}{45} = \frac{5 \times 12}{5 \times 9}$$

The numbers in this expression are now raised to higher values by multiplying with trial numbers in the usual manner, thus obtaining larger numbers corresponding to the numbers of teeth in available change-gears. Thus,

$$\frac{5 \times 12}{5 \times 9} = \frac{(5 \times 16) \times (12 \times 5)}{(5 \times 16) \times (9 \times 5)} = \frac{80 \times 60}{80 \times 45}$$

The numbers above the line represent the driving gears which have 80 and 60 teeth, respectively, and the numbers

below the line the driven gears, with 80 and 45 teeth, respectively. Of course there are other combinations that would give the same ratio, and it might be necessary to calculate them by selecting other trial numbers, assuming, for example, that it were not possible to find change-gears corresponding to one or more of the numbers obtained by the calculation.

Hobs Used for Spur Gears

Hobs for spur gears are made by cutter manufacturers for cutting gears of various diametral pitches, the pitch being stamped on the end of the hob. The normal pitch of the hob should be the same as the circular pitch of the gear. The "normal pitch" is the shortest distance from one thread to the next, the pitch being measured at right angles to the thread. If the pitch of the hob, as measured parallel to its axis, were made equal to the circular pitch of the gear, an error would be introduced owing to the fact that the hob must be inclined to locate it in the working position. However, the difference between the normal pitch and the pitch measured parallel with the axis may be so small as to be negligible when there is little inclination of the hob teeth relative to the axis.

While ordinary hobs must be inclined to align the teeth with the gear on the cutting side, some hobs are so made that they can be set at right angles to the axis of the gear. The included tooth angle on these hobs is reduced in order to obtain the effect of a rack-shaped cutter when the hob is in the right-angle position.

Using Multiple-threaded Hobs

While hobs that have a single thread or row of teeth are generally used for cutting spur gears, multiple-threaded hobs are sometimes employed. An example of spur gear cutting on a Lees-Bradner generator, equipped with a triple-threaded hob is shown in Fig. 5. The operation is that of cutting teeth on the rims of automobile flywheels. A number of these flywheels may be seen at the right-hand side of the illustration. There are 128 teeth of 8–10 pitch. The face width is 1 inch, and the rate of production 125 gears in nine hours, or nearly 14 per hour.

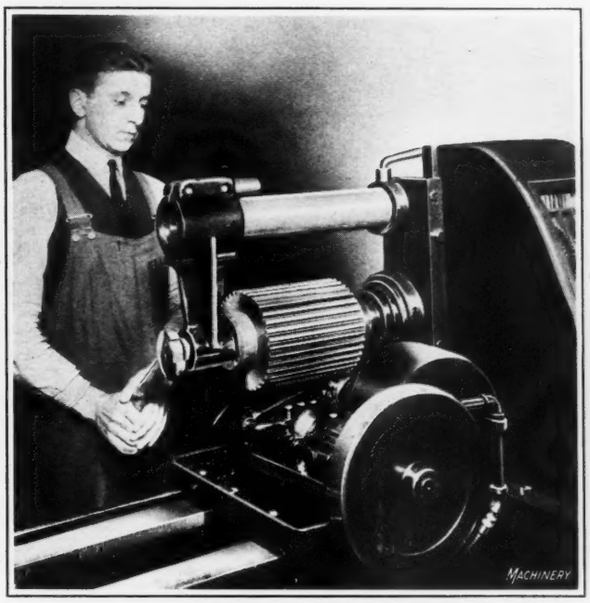


Fig. 4. Another Horizontal Type of Hobbing Machine

When using a multiple-threaded hob, it is necessary, of course, to change the ratio of the gearing controlling the relative speeds of the hob and the work, in proportion to the number of threads in the hob. For instance, when using the machine shown in Fig. 5, driving and driven change-gears of 3 to 4 ratio are used for a triple-threaded hob, whereas for a single-threaded hob the ratio is 1 to 4. In view of the fact that a single-threaded hob must revolve 128 times to one revolution of the gear for the particular operation referred to, whereas a triple-threaded hob revolves only one-third that number of times, it is evident that much greater production is obtained with multiple-threaded hobs, assuming that the same rate of feed is maintained.

To illustrate, suppose that a single-threaded hob is used for cutting a gear having 128 teeth; the hob diameter is 3 inches, and the speed 80 revolutions per minute, thus giving a cutting speed of about 63 feet per minute. Now, assuming that the feeding movement of the hob per revolution of the gear is 0.160 inch, and that the hob has to travel 2 inches for cutting the teeth, then the gear will make 12.5 revolutions while the teeth are being milled ($2 \div 0.160 = 12.5$), and the total number of hob revolutions will equal $12.5 \times 128 = 1600$, since the hob makes 128 revolutions to one of the gear. Hence, the actual cutting time will equal $1600 \div 80 = 20$ minutes when using a single-threaded hob.

Now suppose that the same gear is cut with a triple-threaded hob having the same diameter as in the preceding case and that the same cutting speed and feed per revolution of the gear are employed. Since the triple-threaded hob makes 42 2/3 revolutions to one of the gear, the total number of hob revolutions during 12.5 revolutions of the gear will equal $42\ 2/3 \times 12\frac{1}{2} = 533\ 1/3$. Therefore, the cutting time equals $533\ 1/3 \div 80 = 6\ 2/3$ minutes, or one-third of the time required when using a single-threaded hob for the same work.

Notwithstanding the relatively high production obtained with multiple-threaded hobs, the single-threaded type is preferable for hobbing spur gears, as a general rule, because it generates more accurate teeth. This is due to the fact that a multiple-threaded hob has a larger helix angle than one with a single thread, unless the diameter of the multiple-threaded hob is increased in proportion to the number of threads. Because of this difference in the angle of the helix along which the teeth are located, the cutting action and the form produced are different, assuming that the teeth are the straight-sided rack-shaped form commonly used. The general practice of the Lees-Bradner Co. is to use triple-threaded hobs for cutting cast-iron gears, which need not be very accurate. The use of the multiple-threaded hob for cutting steel gears is usually limited to the double-threaded form, and this is only applied to work that does not require the same degree of accuracy that is possible with a single-threaded hob.

It has been shown that a multiple-threaded hob of given size will reduce the actual cutting time in direct proportion to its number of threads, as compared with a single-threaded hob of the same size rotating at equal speed and having an equal amount of feed per gear revolution. The metal is removed at a faster rate by the multiple-threaded hob, because it has, in effect, two or more tools or hob threads working instead of one. Now each tooth of a multiple-threaded hob has to remove more metal per hob revolution than a single-threaded hob, unless the hob diameter and number of flutes are increased in proportion to the number of threads on the hob. This is due to the fact that a single-threaded hob, because of its smaller helix angle, has more turns or thread convolutions, and, consequently, more teeth in contact with the gear being cut or a larger number of cutting edges working constantly, than a multiple-threaded hob of the same size. This point is brought out in connection with the following comment on the use of multiple-threaded hobs by Fred Ross Eberhardt, of the Newark Gear Cutting Machine Co., Newark, N. J.

When using a hob, the amount of feed possible per revolution of the work depends upon (1) the hardness of the material; (2) the revolutions per minute of the hob; (3) the degree of finish desired. The number of revolutions per minute of the hob depends upon the hardness of the material and the feed, which, to be exact, means the thickness of chip for each hob tooth actually working. With a certain hardness of material and a finish requirement permitting

only 0.125 inch feed per revolution of the work, the following examples will be considered:

A gear having 90 teeth of 12 diametral pitch and a pressure angle of 14½ degrees was cut with a single-threaded hob, 2¾ inches outside diameter, having 14 flutes. The hob speed was 100 revolutions per minute, and the feed 0.125 inch per gear revolution. In this instance, about four convolutions of the hob teeth were cutting, and each tooth of the hob removed about 0.002 inch of metal per hob revolution. The finish requirements would not permit a greater feed. If the hob were run at a higher speed (revolutions per minute) it would have dulled too quickly. The limit of production, therefore, seems to have been reached with this hob.

With all other conditions the same as in the preceding example, but using a triple-threaded hob, only about one and one-third convolutions of the hob teeth were cutting in each tooth space. Therefore, each hob tooth removed about 0.006 inch of metal per hob revolution. The feed per revolution of the work remaining the same, this triple-threaded hob would leave feed marks of the same appearance as the single-threaded hob previously referred to, but the cutting time would be one-third that of the single-threaded hob.

While these are actual examples of work done in the Newark Gear Cutting Machine Co.'s shop, there might be different cases. Each tooth of a multiple-threaded hob does so much more work than each tooth of a single-threaded hob of the same diameter, using the same feed, that the hardness of the material might necessitate reducing the feed per revolution of the work to reduce the chip thickness per hob tooth; however, according to the experience of the company just referred to it is seldom possible to feed single-threaded hobs as much as the teeth will stand, because such coarse feeds would cause unsightly feed marks. As the appearance of the cut usually determines the maximum feed, the use of a multiple-threaded hob makes it possible for each hob tooth to take as large a chip as it can efficiently. It is assumed that the hob has a sufficient number of flutes to give the required generating action. Another point worthy of consideration is that when the number of teeth to be cut is prime to the number of hob threads, the generating flats are the same as for a single-threaded hob of the same diameter, although usually the flats are not noticeable.

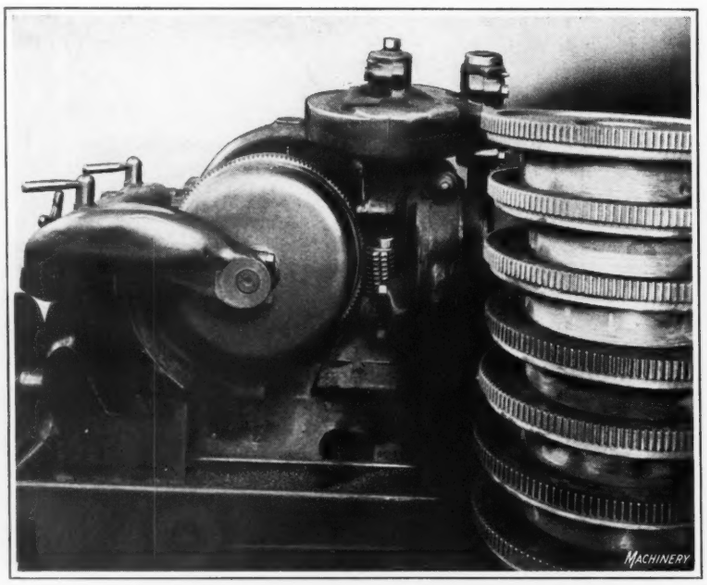


Fig. 5. Cutting Spur Gears with a Multiple-threaded Hob

Hobbing Pinions Having a Small Number of Teeth

Sometimes it is desirable to use pinions having a very small number of teeth in order to obtain a certain velocity ratio and at the same time a relatively small center distance between pinion and gear. When an ordinary pinion is used (having a pressure angle of 14½ degrees) 12 teeth is generally considered the minimum number. Even with a pinion of this size, the flanks of the teeth must be under-cut somewhat to avoid interference, provided the mating gear has more than twelve teeth, and this interference and the need for under-cutting increases if the pinion is to run with larger gears.

A method of improving the shape of the pinion tooth that has long been employed consists in enlarging the pinion blank and reducing the gear blank a corresponding amount. Another method is to increase the pressure angle of the gearing, and a third method consists in modifying both the pressure angle and the blank diameters in order to obtain a tooth shape giving the best results.

Enlarging the pinion blank and decreasing the gear blank a corresponding amount is applied not only to spur gears but also to bevel gears, worm-gearing and herringbone gears. When cutting an enlarged pinion or a reduced gear (whether by hobbing or on a generating shaper or planer) the procedure is the same as when cutting standard gear teeth, and any generating type of machine may be used. The teeth are cut to the full depth on both pinion and gear, and in the usual manner, but if the position of the cutter relative to the gear blank is checked by measuring the tooth thickness, then the change in the height of the pinion and gear addendum must be taken into account, the tooth thickness being measured where the pitch circle crosses the tooth in each case.

For instance, when using a gear tooth caliper for measuring the tooth thickness of the pinion at the pitch line, it must be set with reference to the long addendum. This tooth thickness will exceed one-half the circular pitch, because the same number of teeth have been formed on a blank of larger circumference than standard for that pitch. On the contrary, when measuring the mating gear, the caliper should be set with reference to the short addendum to check the thickness at the pitch line, and the gear teeth are thinner than one-half the circular pitch, because the blank diameter has been decreased.

On account of these changes, the formulas used for determining the chordal thickness and corrected addendum of standard spur gears must be modified. When the blank diameter is changed, the following formulas may be used, in which T = chordal thickness at pitch circle; D = pitch diameter; X = circular thickness of tooth on pitch circle; R = pitch radius; and H = height of tooth arc or amount to add to long or short addendum to obtain corrected addendum.

$$T = D \times \sin \frac{90\,X}{R \times 3.1416}$$

$$H = R\left(1 - \cos \frac{90\,X}{R \times 3.1416}\right)$$

To obtain the value of X, first find the difference between the normal and the modified addenda and multiply this difference by the tangent of the pressure angle of the gear. For a pinion *add* twice this product to one-half the circular pitch to find the value of X; for a gear, *subtract* twice the product instead of adding.

When the pinion blank is enlarged and the gear blank reduced, as described, without changing the pressure angle, the practical effect is to move the pinion teeth outward radially and the gear teeth inward a corresponding amount relative to the pitch circles as well as to the base circles from which the tooth curves are derived. In order to understand why the shape of the pinion teeth is improved by

enlarging the blank, it must be remembered that the base circle of the pinion is much closer to the pitch circle than the base circle of a comparatively large gear. This is due to the fact that the diameters of the base circles for the gear and pinion must be in the same ratio as the diameters of the pitch circles or as the numbers of teeth. For instance, if the gear is four times as large as the pinion, the base circle of the gear must also be four times as large as that of the pinion, and the pinion base circle will be proportionately closer to its pitch circle.

In this connection it is important to note that an involute curve cannot extend below the base circle from which it is derived. Now, unless prevented in some way, the part of the tooth below the base circle of a small pinion of standard proportions will be under-cut if generated in the usual manner, thus showing that the teeth of a gear, and especially the teeth of a straight-sided involute rack, would interfere unless this under-cutting had taken place. This explains why standard 14½-degree pinions in small sizes are not recommended.

When the pinion blank is enlarged, as described, the base circle diameters remain the same and the pitch circle and base circle of the pinion cross the tooth near the root; consequently, the involute curve extends over a larger part of the tooth since the latter has been moved outward, thus increasing the amount extending beyond the base circle. As the length of the involute is increased, that part below the base circle where under-cutting occurs, is correspondingly decreased. It should be remembered, however, that this improvement in the shape of the pinion tooth is at the expense of the gear tooth, which is moved inward relative to its pitch circle and base circle. The extent to which the shape of the gear teeth is sacrificed decreases as the size of the gear increases and is considered negligible for gears having, say, 40 teeth or more.

Changing the blank diameters as described does not affect the velocity ratio of the gearing, since this depends upon the relative diameters of the pitch circles, or the number of teeth in the gear and pinion. The center distance also remains the same, provided the gear is reduced an amount equal to the pinion enlargement. An enlarged pinion does not necessarily have to be used with a gear of reduced size, as it will mesh with any gear in an interchangeable series, but if the mating gear is standard, the center distance will be increased an amount equal to one-half the increase in the pinion blank diameter.

Determining Diameter of Enlarged Pinion Blank

When a pinion blank is enlarged to avoid under-cutting, the increase of diameter may be determined by the following formula, in which O = outside diameter of blank; B = pressure angle; D = pitch diameter; and W = working depth.

$$O = \cos^2 B D + 2W$$

To maintain the same center distance between the gear and the pinion, the gear is reduced by the same amount that the pinion blank is increased.

* * *

HOSPITAL FOR INDUSTRIAL INJURIES

The first hospital intended specifically for industrial workers who have been injured in the course of their employment, is the Reconstruction Hospital at 100th St. and Central Park West, New York City. Here patients have been treated from every industrial state east of the Mississippi, and a new eleven-story addition is now under way, to provide room for additional patients who have been injured or contracted diseases as a direct result of their industrial employment. The aim of those in charge of the Reconstruction Hospital is to make it an institution upon which hospitals all over the country can be modeled, and to give instruction to medical students and post-graduates in the modern science of industrial medicine and surgery, as well as to train nurses in industrial plants.

CHECKING DIAMETER OF TAPER PLUG GAGE

By W. G. HOLMES

In checking the diameter at the small end of a taper plug gage, the gage is first mounted on a sine-bar as indicated in Fig. 1 so that the top of the gage is parallel with the surface plate. A disk of known radius r is then placed in the corner formed by the end of the plug gage and the top side of the sine-bar. Now by determining the difference in height between the top of the gage and the top edge of the disk, the accuracy of the diameter B can be readily checked.

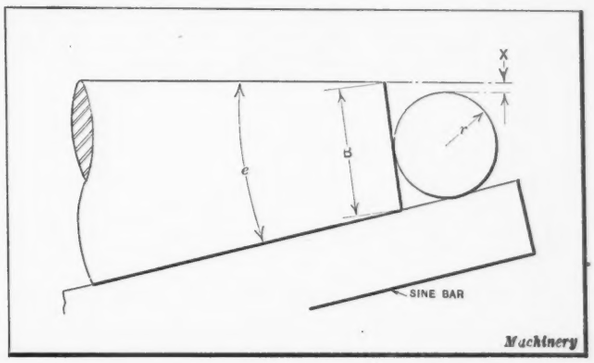


Fig. 1. Gage in Position for checking Diameter B

The known dimensions are:

e = angle of taper;

r = radius of disk; and

B = required diameter at end of plug gage.

With the dimensions given, it is required to find the difference X between the height of the top of the gage and the upper edge of the disk. Referring to Fig. 2 we have,

$$g = 90 \text{ degrees} - \tfrac{1}{2} e \quad \text{and} \quad k = \tfrac{1}{2} g$$

By trigonometry,

$$F = \frac{r}{\tan k}; \quad E = B - F; \text{ and } \tan m = \frac{r}{E}$$

Also

$$P = \frac{r}{\sin m}; \quad n = g - m; \text{ and } H = P \sin n$$

Therefore, $X = H - r$ or $r - H$, depending on whether or not the top edge of the disk is above or below the top of

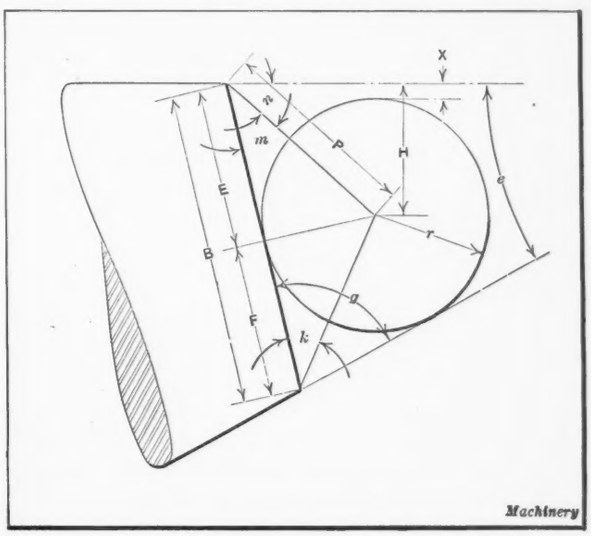


Fig. 2. Diagram used in calculating Dimension X

the plug gage. In the illustration the top of the disk is below the top surface of the plug gage so that it is evident that $X = H - r$.

Sine-bar Fixture for Accurately Checking Thread Angles

In making screw thread plug gages, hobs, taps, etc., the thread or tooth angles may be tested by means of the sine-bar fixture described in the following. This fixture is simple in design, but very accurate as a means of checking angles, and is used by the Pratt & Whitney Co. whenever such a test is required in connection with work of the classes referred to. The fixture is used in conjunction with a bench lathe. It is held on the tool-slide, and the gage or other piece to be tested is placed between the lathe centers. If the angle is not standard, the error may be readily determined.

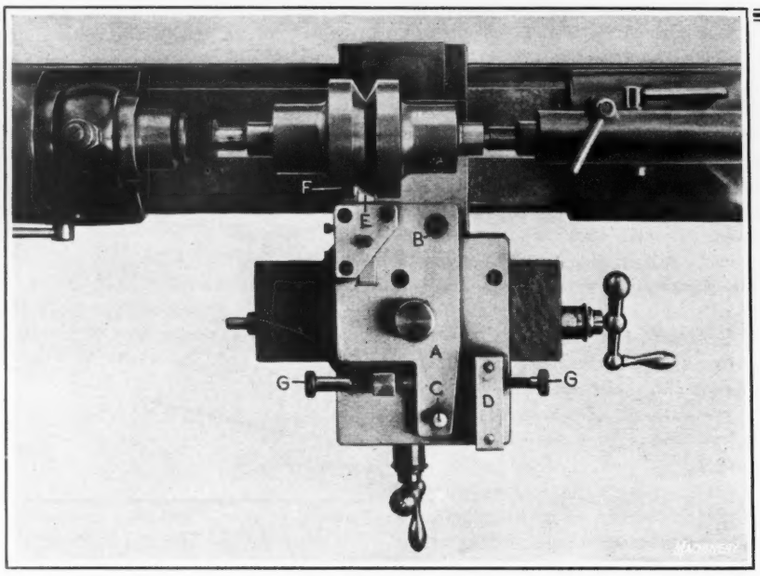


Fig. 1. Adjusting Sine-bar Fixture by Means of a Master Plug

This fixture has a plate *A*, Fig. 1, which is free to swivel about pivot *B*. This plate, which is used like a sine bar, has a projecting plug at *C*, opposite block *D*, from which measurements are taken with an ordinary micrometer. A gaging or contact point *E*, having an accurately ground V-shaped end, is secured to the sine-bar plate by the set-screw and holder shown. Before using the fixture, one side of this V-shaped end is set in alignment with the conical surface of master gage *F*, which has the standard angle required. In making this adjustment, screws *G* are used for shifting the sine-bar plate as required.

The master gage is next replaced by whatever gage, hob, or tap is to be tested. When the V-shaped gaging point *E* is brought into contact with the side of the thread or tooth, even a slight lack of alignment may be detected without the aid of a magnifying glass. Assuming that there is an error in the angle, a measurement is first taken, in the manner illustrated in Fig. 2; the sine-bar plate is then adjusted as shown in Fig. 3 until the gaging point is in perfect contact, as nearly as can be observed. The magnitude of the error is indicated by the difference between these two micrometer readings. The length of the sine bar or the distance between the centers of pivot *B* and plug *C* is such that a difference of 0.0001 inch in the micrometer readings is equivalent to an angular error of 5 seconds. This general rule, which makes it very convenient to determine errors without calculation, is accurate enough for practical purposes unless the errors are larger than those ordinarily encountered. If the bar were moved more than, say, 2 degrees, because of angular error, it would be advisable to calculate the error instead of using the rule referred to.

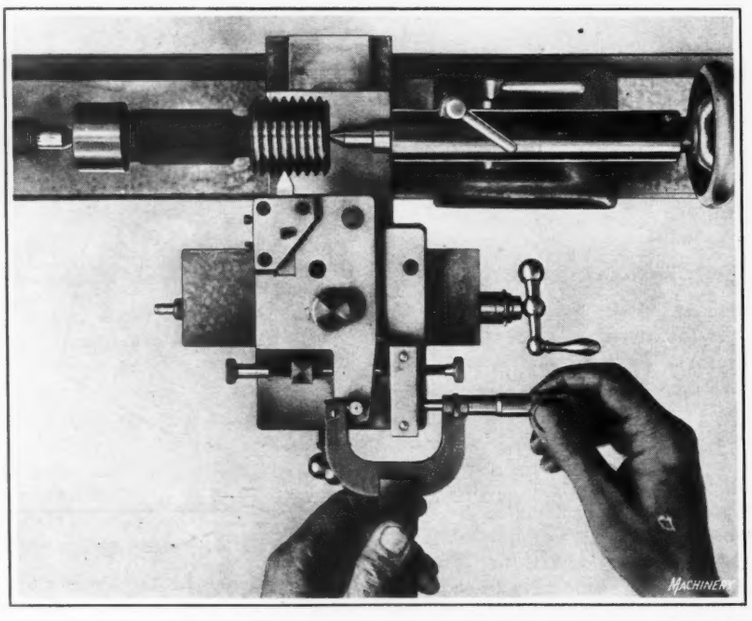


Fig. 2. Measuring Distance to Plug on Sine Bar

There are two general methods of using this fixture. One is to test one side of a thread at a time, the work being reversed between the centers for testing the opposite side. The other method is to test both sides at the same time by adjusting the V-shaped point until it makes contact with both sides instead of one side only. The second method is sufficiently accurate for most work, because the V-shaped points are carefully ground to standard angles, and they have clearance like a thread tool, so that the lines of contact are along the upper edges only.

Accuracy of Readings Obtained with the Sine-bar Fixture

It might be supposed that accurate results would be impossible with this fixture, inasmuch as its use depends entirely on the alignment of the V-shaped point, which, in turn, is a matter of judgment and vision. In this connection it is interesting to know that three men not particularly skilled in using such a device, each tested a thread of ⅛-inch pitch, and all came within 10 seconds of the same reading. A fourth man varied by 20 seconds. A skilled inspector is able to repeat readings within 5 seconds on plugs having eight threads per inch, and within 15 seconds when the threads are as fine as twenty per inch.

EQUIPMENT OF UNIVERSITY SHOPS

By WARREN ICHLER

The aim of any technical school is to furnish the broadest possible instruction along engineering lines. In spite of this, however, we find numbers of universities and technical schools equipped with, say, fifteen or twenty engine lathes of one make which are all exactly alike; two or three milling machines from one manufacturer that differ in general features only in that some are plain millers and some universal machines, and so on down through the list, except, of course, for the more bulky and special machines where one unit is sufficient for instruction purposes and where, perforce, there can be no duplication.

Possibly a laudable desire for standardization—that is, laudable in nearly every business except that of instructing engineering students—has led to this standardization of equipment, but it will be plain to anyone familiar with machinery that any school shop so equipped can give only limited instruction in the use and care of machine tools. Lest this be considered as merely destructive criticism, the writer ventures a few suggestions as to how he endeavored to broaden his courses while a machine shop instructor at a state university.

The first and most important step toward overcoming the disadvantages of a limited tool equipment was taken when inspection trips to nearby shops and factories were substituted for one shop or laboratory instruction period each month. Instead of making these trips general in their nature, an effort was made to confine the inspection to one particular machine or class of machine. For example, one trip to a large shop was made to study vertical boring mills since the vertical boring mill was not included in the university's equipment. Of course, this method of instruction is as old as the teaching profession, but too much emphasis cannot be laid upon it, as the students see work being performed under actual manufacturing conditions.

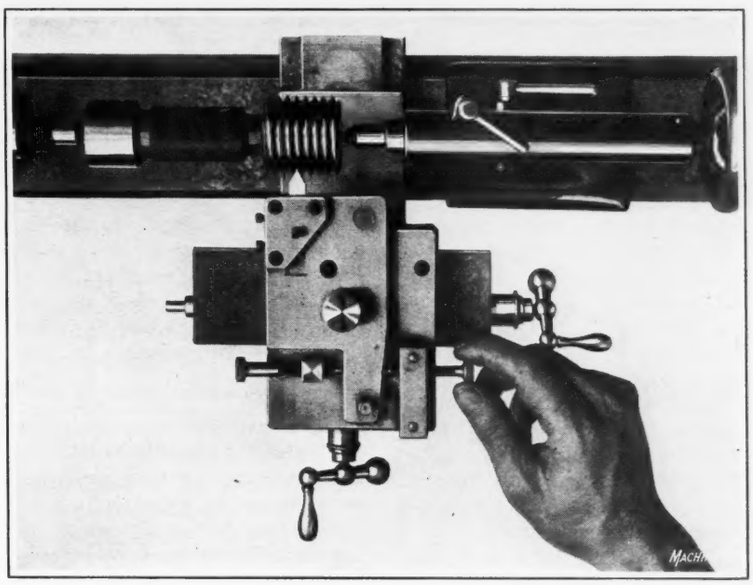


Fig. 3. Adjusting Sine Bar to align V-shaped Point with Gage Thread

Use of Pictures for Instruction Purposes

A second method of supplementing the regular university course was by the use of pictures of machine tools, and in this connection the writer would mention that the machine tool industry in general responded generously to requests for such pictures. Many instructors spend hours in producing fine blackboard lay-outs of novel or special machines, but it is a question whether these have any more value for instruction purposes than a large well posed picture of the same tool would have.

When not in use for instruction purposes the pictures of machine tools were employed to transform the shop into what may be termed a machinists' art gallery. This was valuable in making what would otherwise have been rather dingy surroundings more attractive. Catalogues, and descriptive matter were secured along with the pictures, and brought to the attention of the students, and finally a quiz on each particular machine that had been made the subject of a lecture was held. One gratifying result of such instruction was the fact that students were often able to explain, while on inspection trips, many novel features in machines that puzzled the mechanics operating the machines.

School Equipment Used for Actual Manufacturing

A third measure for broadening the course was the somewhat radical innovation of inviting the owners of certain small garages and machine shops to send to the university shop such work as could not be handled on their equipment, but was still within the capabilities of the university shop. It must be understood that this work was performed by the mechanics of the shop sending the work, and was paid for on a basis of hourly rental for machines and power, so that in no sense were the students used on contract labor, and the hourly rental basis was fixed at a figure that was attractive to the average manufacturer. In this way, students became familiar with the methods of setting up for more intricate work than that of their regular course and were able to see the little indefinable distinctions that differentiate the work of the skilled mechanic from that of the student. Of course, the methods of the skilled mechanic were studied on inspection trips as well, but of necessity, under less favorable conditions than in the school shops. The school was thus made of real benefit to the community and the money realized from the rental of its machines was available for new equipment. Another plan that was employed was that of asking certain large manufacturers to lend the services of their salesmen or service men for short talks to the classes.

The writer has noted one exception to the usual method of equipping an engineering school shop. In this school which is located in the Middle West, one can search the machine shop through and through without finding two machines that are duplicates of each other. This shop was fortunate in having for its founder a man of wide practical experience, as well as thorough technical training. In a conversation with the writer this man remarked: "Standardization is yet in its infancy, and the boys we are training will not be likely to secure employment in factories standardized as they should be, so why try to surround them with ideal conditions in that respect? Furthermore, no two students are reached by the same methods in the class or shop. We have built up quite a little healthy rivalry with our varied equipment by reason of this principle. That boy over there running that lathe is quite convinced that his is a better machine than the lathe next to it on which his chum is working, because his lathe has a little handier quick-change-gear mechanism than that provided on the other machine. Conversely, the boy on the other lathe is firmly convinced that he can secure a finer finish on his work, and at higher speeds, than his chum because the bed of his lathe is braced differently from that of the other machine and is a little deeper. Just as long as manufacturers strive to outdo each other in producing machines of the highest development, just so long should we strive to bring before engineering students, everywhere, the results of the manufacturers' experiments and experience."

Planning in Large Contract Plants

Problems Relative to the Installation of Planning Departments

By GEORGE H. SHEPARD, Professor of Industrial Engineering and Management, Purdue University

EFFICIENT planning means not only the giving of instructions for performing work in the most economical manner, but also the scheduling of the various jobs to insure their completion on the desired dates. In the machine shop using the cards and records shown in the previous article on this subject, which appeared in March MACHINERY, the percentage of jobs completed on time increased greatly immediately after the installation of the planning system. The chart in Fig. 1 illustrates diagrammatically the results obtained in this shop during a period of over six months. At the time the system was installed, only about 45 per cent of the jobs were completed according to schedule. The percentage line gradually rises until it reaches the 100 line one month from the installation date. From then on, the percentage of jobs completed on time is never less than 89.

In connection with planning, it may be found that some jobs run in a sufficient volume to warrant their segregation and a standardized manufacture. Such jobs should be placed on a manufacturing basis as soon as possible.

Personnel of a Planning Department

In building up a planning organization, care must be taken to select a competent personnel. This is especially important in contract or jobbing shops, because the continual variation in the work handled makes it necessary to rely on the skill and good judgment of the planners. Hence, only skilled mechanics with a good local knowledge of the shop should be employed. Planners should have an opportunity to advance. The departmental chief planner should have a foreman's rank, and the nature of his job makes him, provided he has executive ability, the logical understudy and prospective successor to the general foreman.

Some executives think that the work of the planning office is an addition to that of the shop and that the employment of mechanics as planners results in a corresponding reduction in productive capacity. But this is not the case. The purpose of a planning department is to increase production. Whether there is a planning department or not, it is necessary to determine the priority of jobs, to see that preparations are made for the work, to combine different jobs in order to obtain the most efficient use of machine set-ups, and to record the progress and completion of jobs. These things can be done more effectively by fewer persons in an office with a specialized organization and records, where there is an opportunity to develop special skill, than on the shop floor in the midst of the distractions of manufacturing. Shop men who are employed in the planning department, no matter how skilled they may be as mechanics, must be trained for the work and be guided until they have acquired the special skill necessary for planning.

Functionalizing Planning and Dispatching

Functionalizing planning and dispatching along the general lines of methods, materials, and progress, has been found advantageous. Another common method is to assign separate sections of a planning office to different work, such as customers' orders, stock, plant maintenance, repair, etc. The method followed must, of course, depend largely on local conditions, but the experience of the writer has been that functionalizing by methods, materials, and progress is preferable for the following reasons: (1) This is a definite classification of specially skilled men who can be used on any job on which their services would be of value. (2) Planners develop higher skill by specializing along these lines than they otherwise would, and a smaller personnel is capable of doing the work. (3) Better coordination of the work as a whole is obtained when all the jobs are handled by the personnel along the special lines outlined, than when the various jobs are handled independently by different people.

When planning and dispatching are first started, a daily priority list may be the only dated schedule for the guidance of the shop, but as the application of these principles proceeds, the amount of scheduled work increases rapidly. For example, soon after a planning organization is functioning, it may be necessary to repair part of the shop equipment. The method man of the planning office foresees the necessity of having this equipment ready for use on some order. The completion date of this order on the priority list establishes the date when the equipment will be needed and therefore determines the completion date for the repairs. Again, as planning and dispatching are installed in the stores department, the planning office begins to issue requisitions for the manufacture of stock parts with completion dates based on the date when the parts will be needed to keep the stock from falling below the minimum limit. In such ways as these the majority of the job orders will gradually come to have completion dates. In contract or jobbing plants usually from 70 to 75 per cent of the job orders finally are scheduled in this way.

Need for Filler Orders

The remaining 25 or 30 per cent of job orders have no definite priority, and this is of considerable advantage. Under contract or jobbing conditions it is impossible for a planning department to see ahead far enough always to provide a definite job for every machine or group of men. In order that supervisors on the shop floor may be able to fill such gaps, it is necessary for them to have some filler work, which can be run to suit conditions; jobs without a definite priority meet this need. A certain amount of filler work should be provided also to stabilize the load on the shops, so as to keep them busy when customers' orders are unavailable.

One means of providing filler work is to manufacture parts for stock when there is a large enough demand to warrant this. In such cases the overhead costs to be distributed over the parts, the cost of carrying the parts in stock, and the comparative cost of shop manufacture relative to the market price of the article should be carefully considered. Parts for which there is a large and steady demand and which can be made profitably, instead of providing filler work, are suitable for production by manufacturing methods. Some stock orders, also, require a too definite and immediate completion date to allow them to be run as fillers.

Notwithstanding these facts, the manufacture of stock parts is the source of the largest volume of filler work in contract plants. Another convenient source of filler work is the maintenance of shop equipment. This should properly be the responsibility of a separate department, specially organized for the purpose, but the variety of such work in a contract plant makes the expense of a completely equipped maintenance department prohibitive. In order to use plant maintenance jobs as filler work, ample notice must be given of the needed repairs. This requires the installation of a system of constant and thorough inspection of equipment, which will make the need for repairs apparent well in advance of the time when immediate repairs are necessary.

Centralization and Decentralization of Planning

The question of centralization and decentralization comes up continually in the installation of planning systems. A correct balance must be maintained between the two if the work of the planning department is to be successful. While it has been found desirable to install a central planning office to deal with the plant as a whole, it has been found equally desirable to leave the details of departmental planning to the departmental offices. The function of the central planning office should be to make the first analysis of orders, determine in general the methods to be followed in filling the orders, decide what materials are to be used, order the stores department to provide and reserve these materials, place in general terms the orders on the shops for the work to be done, determine the final delivery date of a job and the completion date for every shop on all but filler work, follow up the progress of work from shop to shop, and settle questions of conflicting priorities referred to it by the shop or departmental planning offices.

Extent of Decentralization

A point requiring attention in the installation of a departmental planning office is the relation between the general foreman and the departmental chief planner. The former is likely to think that the latter is placed over him and to resent the whole planning scheme, considering it an attempt to undermine his authority. It should be made plain, therefore, at the beginning of a planning installation that the departmental chief planner is a subordinate of the general foreman and that his duty is simply to relieve the general foreman of details, in the same way that the other foremen do. The responsibility for meeting completion dates rests on the general foreman, and he has the authority to give the departmental chief planner whatever orders his judgment dictates. In fact, the general foreman and the chief planner should meet every day for that purpose.

After a departmental planning office has been installed, it is sometimes necessary to decentralize further by installing a sub-departmental office in some section. This second sub-division is likely to be needed in connection with a service section. For example, the tool section of a certain machine shop worked largely on orders from other sections of the shop. It was found impossible for the departmental planning office to foresee much of this work in connection with its analysis of orders, and so this section was finally given a small sub-planning office of its own. The foremen of other sections sent their orders directly to the tool foreman by means of the inter-shop order, described in the March article. These orders were handled by the tool foreman and his planning office without reference to higher authorities, except in case of conflicting priorities and similar questions.

One of the problems of a contract plant, as compared with a manufacturing plant, is the difficulty of assembling data into general summaries, which will give those in control an idea of the relative amount of work in the different departments, and other conditions. It is common for a jobbing plant to pass quickly from a greatly overloaded to an underloaded condition, notwithstanding the fact that the plant has plenty of filler work. This is due to a lack of planning. Some preparation is always necessary for filler work, and if the falling off in customers' orders is not foreseen, the plant will be without this class of work or will be unprepared to take up filler work. One of the main values of a daily prior-

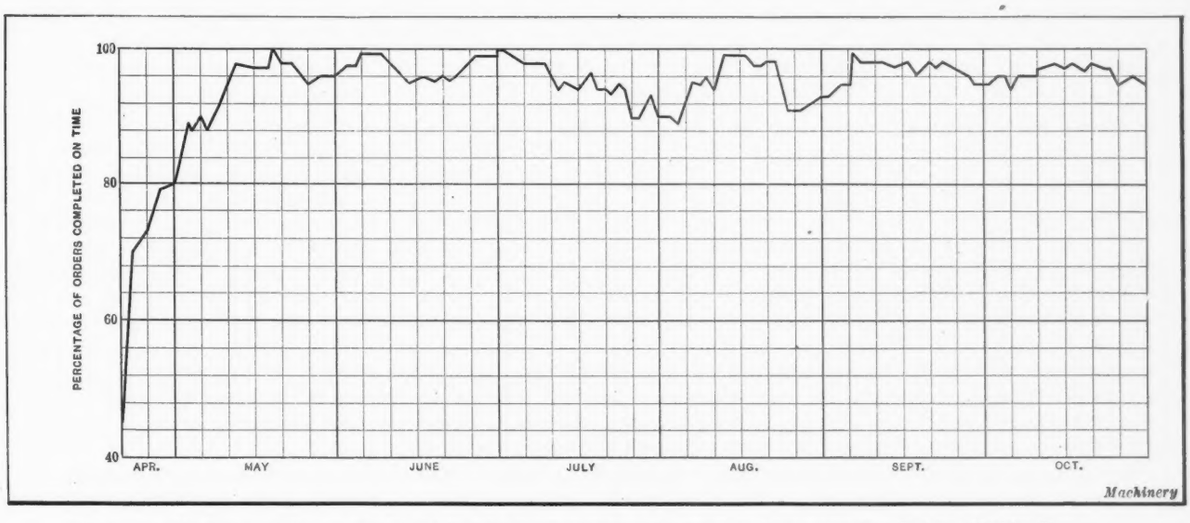


Fig. 1. Graphic Representation of Results obtained by the Installation of a Planning Department in a Contract Machine Shop

ity list is that its regular consideration can hardly fail to bring to the attention of the chief officers of the plant a prospective falling off in the amount of work on the main orders. Besides this, continual attention by planners and shop foremen to schedules and progress of jobs will cause them to notice a prospective falling off in the amount of work and indicate the necessity of looking for filler work and of preparing for it.

A good cost accounting system and frequent balance sheets are particularly necessary in a contract shop so that estimates and bids can be compared with actual costs. The industrial engineer should be continually on the watch for chances to install periodic summaries which will show to the officials the general tendency of matters under their control. Local conditions cause this matter to vary so much that it is useless to go into details; however, as an example, a summarized graphic record of tool loss and damage per man per day in a certain shop is shown in Fig. 2. As soon as general tool-room practice and records had been improved to the point where it became possible to obtain summarized records with substantial accuracy, this monthly summary was made. In the illustration, line *A* indicates the cost of wear; line *B* the cost of tools damaged; line *C*, the sum of the costs of tools worn and damaged; and line *D*, the average total cost. The results for the first three months showed the loss and damage to be going up at an alarming rate. Every month the summary was reported to the works manager, and every foreman concerned was informed of the loss and damage chargeable to his section. Beginning with the fourth month a gratifying reduction in waste was shown.

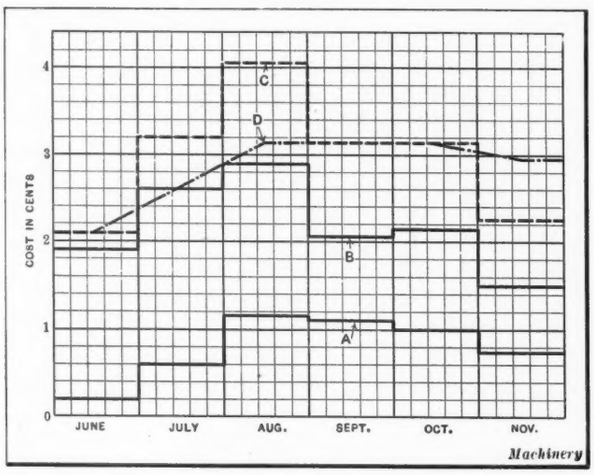


Fig. 2. Monthly Record showing Average Daily Cost of Tool Wear and Damage per Man

If teamwork is to be obtained under the unstandardizable conditions of a contract plant, all means of communication and transportation must be made as convenient as possible. The principal means of communication are the plant mail and the telephone. The former is generally used effectively, but often there is not an equal appreciation of the latter. Every plant official down to, and including the grade of foreman, and in special cases, the assistant foreman, should have a desk telephone. A planning office of any size should have several, and every shop shipping and receiving clerk should have one. These telephones should be connected to a private exchange, and the service should be the best obtainable. Anyone who has experienced the convenience of automatic service in private exchanges will prefer it to a manual exchange on account of the delays and errors customary with the latter system.

Transportation within the Plant

Transportation can be divided into two distinct classes—inter-shop and intra-shop. In a large plant inter-shop transportation should be controlled by a separate department, under its own head, who should report directly to the works manager. The work of this department should be planned and dispatched in detail by its own departmental office. The question of equipment for transportation is important. For intra-shop transportation, the overhead traveling crane is in general use for heavy articles, and the elevating truck (propelled by storage batteries for long hauls) for light loads. For inter-shop transportation, the equipment should consist of a standard gage plant railway, locomotive traveling cranes, and automobile trucks. The latter should be provided with various auxiliary devices for hoisting and quick loading and unloading. During the last few years there has been a great development of conveyors; for the contract plant, the small portable types are the most promising. There seem to be considerable possibilities for effecting economy in the handling of materials by the judicious use of conveyor equipment.

Problems Connected with Transportation

Closely connected with transportation are the problems of locating responsibility for parts during their movement, of preserving their identity, and of securing a proper sorting of materials for convenient handling in the receiving shop. The plant delivery tag for inter-shop movement and the route tag for intra-shop movement are the means of locating responsibility and preserving identity. These tags were discussed in the article previously referred to. Preserving the identity of parts is no small problem when you have in process of manufacture, for example, hundreds of small valves, which are too nearly alike to be identified by casual inspection, but which are not interchangeable. The greatest trouble experienced in the use of tags is that they are likely to become detached.

This is especially true with castings and forgings, and for such parts, a satisfactory solution is to have an identifying symbol painted in black or colored shellac on each part by the shop which produces it. This method could not be followed, of course, if the parts were to be annealed. In such cases identification tags should be provided for all articles, all tags should be removed and kept during the annealing process, all work should be looked over just prior to being placed in the annealing oven, all articles should be re-identified after being annealed and, finally, all tags should be correctly re-affixed immediately after annealing. It is sometimes necessary to have special memoranda or sketches on the tags to insure correct identification. The work outlined may seem considerable, but anyone who has experienced the troubles incident to the loss of identity of steel castings, for example, in and after annealing, in a plant handling large numbers of such parts, will realize that the care necessary to prevent occurrences of this kind is the lesser by far of the two evils.

Storage of Equipment and Large Numbers of Parts

The delivering shop should be responsible for sending its product out properly sorted. If the shop is insufficiently supplied with containers, its shipping force will put the product into the containers on hand, which will result in mixing the orders and will cause confusion in the receiving shop. In order to insure a sufficient supply of containers, there should be a central place for their storage, manufacture, and repair. Then the general foremen may send to the central point all skids for elevating trucks, containers, and tote boxes for which there is no immediate use. This equipment can be looked over, repaired if necessary, inventoried, and stored. When the general foremen need these articles again, they can obtain them through a requisition on the central storage department. The storekeeper of the central storage department should be responsible for keeping a sufficient stock of skids, containers and tote boxes on hand to meet any demand that might arise.

Closely connected with the preservation of identity of parts and the placing of responsibility for them, is the problem of assembling and storing large numbers of parts, such as are often needed for construction or repair jobs. Failure to

solve this problem is serious, because parts are likely to be lost, and even if they are only mislaid temporarily, considerable delay and expense result. On some large jobs, which were expected to require months of work, so that parts would need to be stored for a long time, it proved desirable to establish a complete storehouse with its own force of storekeepers, to receive and store such parts, and to issue them correctly on requisition as needed. The parts were sent to this storehouse at all stages of manufacture, whenever they were not actually being worked on in the shops.

Other troubles are those due to partial deliveries. For example, when a foundry delivers directly to a machine shop, it is almost impossible to keep up such a steady flow of castings that work in the machine shop will not be interrupted. The machines must then either stand idle, or their set-ups must be broken down and later remade. The use of a store-room enables the machine shop to accumulate castings, until it can start an order with a reasonable assurance that there will be a sufficient supply of work to insure that the operation will be continuous, thus eliminating costly delays.

Attention to the progress of jobs through the plant results in cleaning up dead jobs, in preventing their occurrence, and in improving the appearance of the shop. It is common to find a shop with a large accumulation of junk, a great number of dead orders, and tools stored at random. In one instance a clean-up revealed several tons of old tools, the purpose of which in many cases was unknown. In another instance, carloads of valuable scrap metal were unearthed and immediately sold at a good price.

* * *

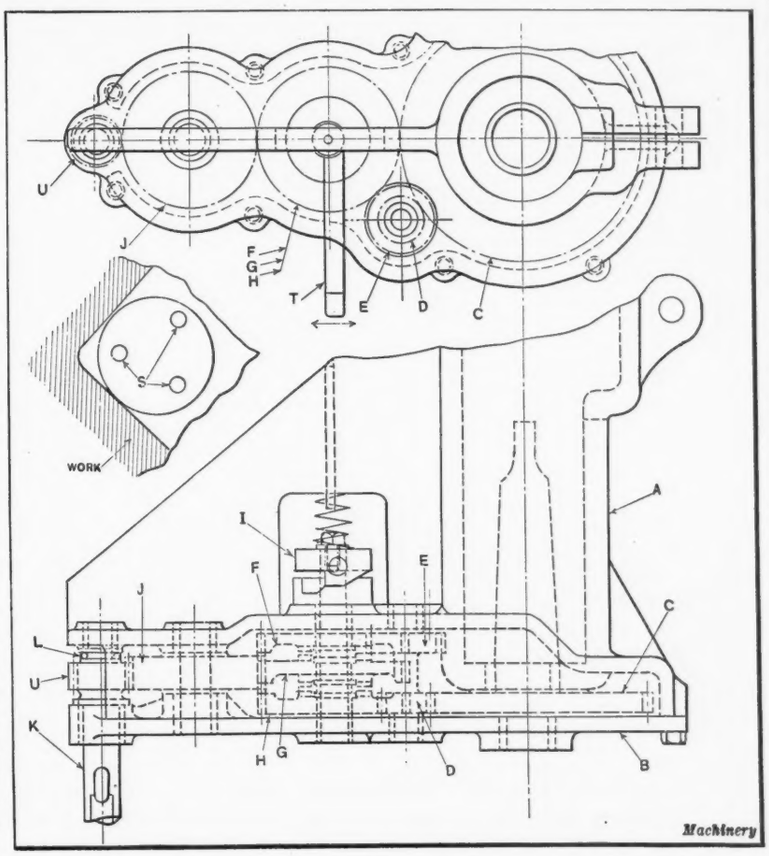
FOREIGN TRADE CONVENTION

The program for the ninth national foreign trade convention to be held in Philadelphia, May 10 to 12, includes a number of both general and group sessions devoted to important problems in the foreign trade field. Among the many questions that will be discussed are the following: "A Foreign Loan Policy that will Enable Idle Factories to get to Work"; "A Practical Method of Putting Our Surplus Gold to Work in Financing Foreign Trade"; "The Effect of High Taxation on the Exchanges"; "The Factor of Depreciated Currency in Competition"; "Protection Against Exchange Losses"; "Uniform Commercial Credit Instruments"; "The Merchant Marine—an International Problem"; "Inland Waterways as Developers of Traffic"; "Marine Insurance"; "Free Ports"; "Meeting Preferential Tariffs"; "Sales Promotion through Advertising"; and "The Essentials of a Market Survey." Further information may be obtained from the National Foreign Trade Council, New York City.

DRILLING AND TAPPING HEAD

By HAROLD A. PETERS

The drilling and tapping head illustrated was designed for use in drilling and tapping three small holes in an engine crankcase. The holes were located in a corner as indicated at *S* and could not be drilled satisfactorily in a regular drilling machine or with any of the small air or electrically driven portable drills available. The drilling head shown differs from the usual type in that it is adapted for tapping as well as drilling. The drilling and tapping head consists of two steel castings *A* and *B*, and a train of gears enclosed by the castings. The top casting *A* is designed to be clamped to the drilling machine spindle housing, and the lower casting serves as a cap to enclose the gear train. The gear train is so arranged that the small auxiliary tapping spindle *K* can be revolved in either direction, or stopped by simply manipulating lever *T*. Although the illustration is diagrammatic, it will serve to show the location of the various gears comprising the gear train and give a good idea of the general construction of the device.



Drilling and Tapping Head for Use in drilling Three Inaccessible Holes

A Morse taper shank, turned integral with gear *C*, fits into the drilling machine spindle after the head is clamped in place on the spindle housing. Gear *C* is always in mesh with gear *D*. Above gear *D* on the same shaft is a slightly larger gear *E*, which is in mesh with the upper clutch gear *F* while the taper shank gear *C* is in mesh with the lower clutch gear *H*. The center clutch gear *G* slides up and down on the shaft, but gears *F* and *H* are kept in the position shown by the stationary bushings on which they revolve.

Clutch gear *G* is raised until its clutch jaws grip those of gear *F*, or lowered until they grip those of gear *H*, by means of the clutch *I*, which can be rotated on its axis by lever *T*. Drill socket *K* can thus be revolved to the right or left, or stopped, by manipulating lever *T*, as previously mentioned. When lever *T* is in the position shown, gear *G* is held in a neutral position and no movement is imparted to socket *K*. Gear *G* is always in mesh with the idler gear *J* as shown, and gear *J* is constantly in mesh with the drill socket gear *U*. A small ball thrust bearing *L* takes the thrust of the drill or tap. The gears are all heat-treated to insure long wearing qualities. A drilling head of this type which has been in constant use for about eight months is giving excellent service, although it has been subjected to unusually severe service.

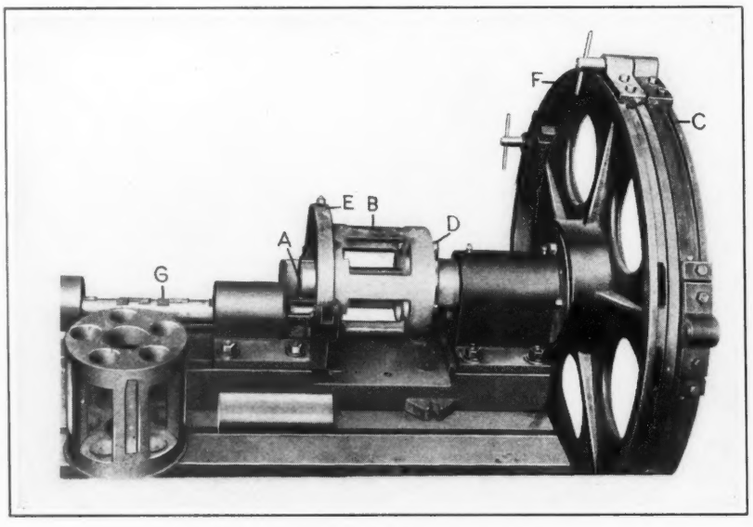
* * *

Exports of automobiles during 1921, according to the Department of Commerce, totaled 41,392 cars, of which approximately 14,000 cars went to Latin America and about 6000 cars to Canada.

BORING AND MILLING FIXTURE

Two drum-shaped cast-iron heads are provided on the Davenport multiple-spindle screw machine; one of these revolves and carries the five work-spindles, and the other is stationary and carries the tool-spindles. The revolving head has five longitudinal slots machined in it to receive the steel blocks by means of which it is indexed. The boring of the five holes in each of these cast-iron members, as well as the milling of the five index-block slots, is performed by the use of the special boring and milling fixture illustrated. Accuracy was the chief consideration in designing this fixture, as it is essential that all spindles be equally spaced, that they be parallel and that the radial distance from the center of the castings be the same for all holes. The milling of the slots in the revolving head must also be done with the same degree of accuracy.

For boring the holes, the fixture is placed on a Rockford horizontal boring and drilling machine. The fixture has a solid base machined for attaching three bearings, the foremost of which carries the spindle *A* on which the work *B* and the index-wheel *C* are mounted. The other two bearings, which are in line with the spindle bearing, carry the boring tool. All three bearings are bushed with steel. The work is driven by finger *D* which extends into a hole machined in the end of the casting, and is secured by a collar which screws on the end of the spindle. An outboard support is furnished in the form of a cradle having a hinged cover *E* which secures the work in position during a boring or milling operation and which must be released while indexing the work to the next position.



Boring and Milling Fixture of the Indexing Type

At the outer extremity of the spindle bearing is attached a flange to which a stationary wheel *F* is bolted. This wheel carries two locating plug blocks which are fitted to the periphery by means of a tongue and groove and which are located so that the plugs may be properly aligned with similar blocks attached to the periphery of the index-wheel. Five of these index plug blocks are attached to the periphery of the index-wheel, and they are set to the correct chordal distance by the use of plugs and verniers. These wheels are 40 inches in diameter, and the pitch circle on which the holes are bored in the work is 6 inches in diameter, so that an error of 0.001 inch in the setting of the plugs is reduced to less than 0.00015 inch in the spacing of the holes. After these locations have been accurately obtained, the two blocks on the stationary wheel are set by the use of the knurled handle plugs shown, and during the indexing of the work it is necessary that both of these plugs enter corresponding holes in the blocks on the revolving wheel. The plugs are made of hardened steel, and the blocks are furnished with steel bushings.

A special Kelly reamer *G* is used in boring the holes. This bar carries six blades, three for finishing the holes in the front wall of the castings and three for the holes in the rear wall. The first cutter-blade stocks out the holes, while the second is a fly cutter for finish-boring, and the third is a double blade for reaming. Corresponding cutters in each set of three feed through the work before the next cutter starts operating so that there is no tendency for the boring-bar to become cramped and cause inaccuracies or misalignment of the holes. The boring-bar is driven by a floating holder or chuck; thus it is free to adjust itself so as to maintain its parallelism with the work-carrying spindle, established by the alignment of the boring-bar bearings.

The revolving head is shown resting on the base of the fixture. The axial hole of this casting is larger in diameter than the hole in the stationary head, so that it is necessary to use a sleeve to fit in this hole in order that the same work-holding spindle can be used. For milling the parallel grooves in the revolving head the fixture is attached to a Milwaukee milling machine.

* * *

INSPECTING THERMIT WELDS

Progress in welding methods has been retarded by the fact that the actual strength of a weld cannot be determined without destroying the weld itself. An examination of the surface of a weld does not reveal its strength. For this reason, technical societies and associations accepting the responsibility of setting standards have naturally been severe in their restrictions regarding specifications for and the allowable application of welding. According to the Metal & Thermit Corporation, however, definite conclusions as to the strength of a thermit weld may be drawn from a careful interior inspection of the collar or reinforcement section of the weld.

In thermit welding, it is said to be impossible for defects such as lack of fusion or oxide inclusion to exist, if the proper amount of thermit is used and if instructions are carefully followed. Oxide inclusions (due, for example, to the failure to clean scale properly from wrought-iron sections before welding), if present at all, will always be in the thermit steel collars due to the natural tendency of the gases to rise in the molten mass. An examination of the interior of the collar can be made without materially affecting the strength of the weld. Thus unsound welds can be found and condemned.

In practice, this examination is made by gouging deep grooves in the thermit steel collars parallel with the axis of the piece. These grooves may reach almost to the original section itself. Two grooves on each of the four sides of a thermit weld have been found sufficient. If these grooves are observed to be clean and free from blow-hole defects, the inspector may be assured that the weld itself is sound.

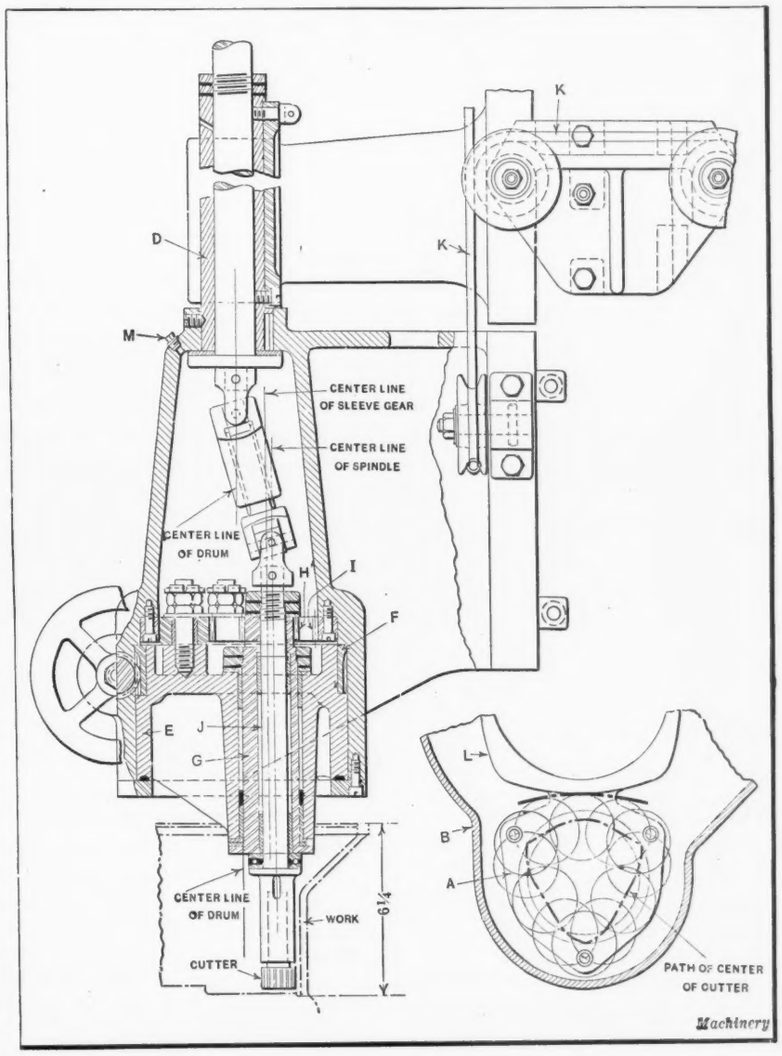
* * *

A new chromium-nickel steel is said to have been developed by the Armstrong-Whitworth Works in England, which, it is claimed, does not have the brittleness present in nickel-chromium steels when subjected to certain heat-treatments. The new steel is said to be highly resistant to torsion and shock, which makes it particularly adaptable for use in turbine rotors and for crankshafts and other shafts subject to high stresses when running at high speeds. It has been given the trade name "Vibrac," and is understood to be the result of researches carried on at the company's Openshaw Works in Manchester, England.

Geared Milling Head for Profile Work

By A. B. BASSOFF

THE special geared milling attachment here illustrated was designed for end-milling a flat pad in a transmission gear-case casting. This surface *A* is triangular in shape, and located within the casting 6¼ inches from the end. The circular wall *B* merges into the bell-shaped casting proper and produces a very restricted area within which to work, requiring the use of long slender spindles if the work is produced in a milling machine in conjunction with former plates. The use of former plates is usually objectionable, because they introduce the human element, and often result in rejected work due to the failure of the operator to follow the outline of the profile plate. There is a raised surface *L*, approximately rectangular in shape, which is adjacent to one side of this triangular pad, so that it was impossible to face the surface in a lathe. At the point where the rectangular boss joins the pad the casting has a draft, and it was necessary to cut into this metal along the contour shown by the heavy dot-and-dash line, in order to accommodate the plate which was to be attached to the finished surface of the pad.



Geared Cutter-head used for end-milling Inaccessible Flat Surface

The problem of machining the surface and of following the desired contour was solved by the use of a head which is shown in section in the illustration. This attachment was designed to be used on a 24-inch Cincinnati drilling machine, to which it was applied in place of the regular quill and spindle, the quill *D* of the attachment being inserted into the spindle bracket, in place of the regular construction. The milling head consists of a body casting or case which was designed to fit the regular slide on the column of the machine. This casting has attached to it, at the top, a quill *D* for accommodating the special spindle of the milling head. Within the lower end of the case a drum *E* is contained, and this drum has a spiral ring gear *F* keyed to it so that it may be revolved by means of the handwheel shown and a small spiral pinion meshing with the ring gear. The drum has an eccentrically located neck extending down through the retainer plate that holds the drum in position, and that carries within it a sleeve *G* in which there is cut a gear *H* at the upper end. This gear rotates the sleeve through the internal ring gear *I*, which is attached to the inside of the case, and a train of two gears. The spindle *J* that carries the cutter at the lower end is located eccentrically relative to the center line of the sleeve, and runs in bearings. It will be seen that the upper end of the spindle is connected, through universal joints and a telescopic sliding shaft, to the upper vertical spindle which has its bearings in the quill, and which is driven similarly to the regular drilling machine spindle.

Operation of the Head

With each half revolution of sleeve *G* the cutter-spindle *J* is alternately advanced toward the center of the drum and receded from it, due to the eccentricity of the spindle relative to the center of the sleeve gear *H*. The ratio between the sleeve gear and the large stationary ring gear *I* is 3 to 1, so that when the large drum has made one complete revolution, the cutter-spindle will have advanced and receded radially three times, and in so doing the path of the cutter will follow a regular figure having three high points and three low points midway between them, corresponding to the general triangular shape of the pad to be machined.

The partial view of the interior of the transmission case in the lower right-hand corner of the illustration indicates, by broken outline, the path that the center of the cutter-spindle takes during one revolution of the drum. From this view it will be seen that the course of the cutter corresponds very nearly to the contour of the pad. It will be noticed that the movement of the spindle is not an abrupt rise and drop, but a curve very nearly parallel to that of the outline of the surface to be milled.

The cutter is fed to the work in the same manner that a drill spindle is fed, the vertical location being established

by the use of stop-collars such as are regularly furnished with the machine. After the head has been fed to the proper depth, it is clamped in place by two clamping bolts which bind the body casting to the column of the machine through the medium of the regular dovetailed slide construction. The operator then turns the handwheel until the drum *E* has made one complete revolution, and as has already been explained, this completes the cut. Only one cut is taken across the surface, the finish produced being sufficiently flat and free from chatter marks.

The position of the work is shown in broken outline in the illustration, with the cutter adjacent to the surface to be machined, and although no fixture is shown, it is understood that any suitable device for holding the work will be adequate. The entire mechanism runs in oil, the top of the case being provided with a filling plug *M* and also a drain plug at the bottom of the casting, thus permitting the oil to be renewed from time to time. Obviously the weight of an attachment of this kind is considerable, necessitating additional counterweights for returning the spindle to its upper position. These are provided at the rear, and a wire rope *K* is connected to them, passing through a series of pulleys in and around the head, so as to equalize the strain produced by the weight of the attachment on the dovetailed slide.

* * *

In "The Transactions" of the American Institute of Mining and Metallurgical Engineers, it is stated that an investigation of the so-called "fatigue of metals under stress," covering a period of a little over a year, has shown more conclusively than has been shown before that steel under repeated applications of stress, reversed from positive to negative, will not fail below some fairly clearly defined limiting stress which, however, so far as can be determined, does not bear any definite relation to the ordinary elastic limit, being as large as the elastic limit in some cases and about one-half the elastic limit in others.

SPRING PLUNGERS FOR FIXTURES

By H. P. LOSELY, Industrial Engineer, Detroit, Mich.

Three supporting points determine the plane in which a given piece of work will lie when clamped in a jig or fixture. However, it is sometimes necessary to provide more than three points of support in order to take up the thrust of the cut and prevent the piece from being distorted and machined out of alignment. When rough or unevenly machined surfaces are being dealt with, these extra supports must be adjustable. The piece may then be laid on the three fixed points and the adjustable supports brought in contact with the piece and locked, so that the work will be firmly held in position.

While there are various other types, the most economical adjustable support to use on a production job is the spring plunger, which consists of a cylindrical plunger pressed against the work by means of a spring. The plunger is held in place by a screw. The simplest way to make a plunger would be to mill a flat on the cylindrical surface and let the clamping screw bear directly on this flat; however, this is not good construction, because the vibration of the cut is likely to make the plunger slip so that it does not support the part properly.

To avoid this trouble, the plunger construction shown in Fig. 1 has been devised. This plunger has a flat milled on the cylindrical surface at an angle of 7 degrees with the axis, and the use of an intermediate plug between the screw and the plunger prevents the latter from being burred and locks it securely in position when the screw is tightened. Both the plug and plunger should be made of drill rod and hardened; the clamping screw may be made from cold-rolled stock, and cyanide-hardened. Either a plain hexagonal-head machine screw may be used or a pin may be driven through the head to assist in rotating the screw. This pin should be at least ¼ inch in diameter, so that it will be heavy enough to withstand hammer blows. The

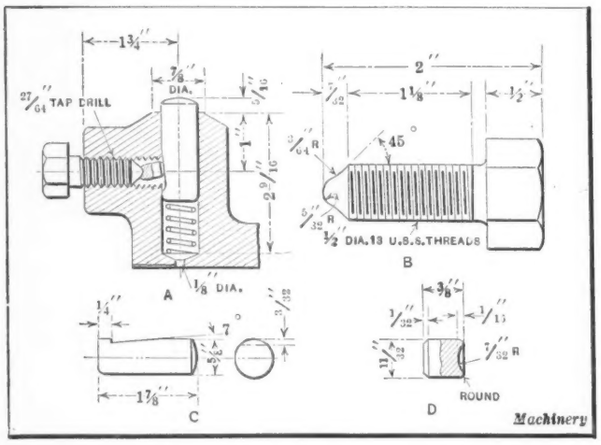


Fig. 1. Standard Design of Spring Plunger Construction for Jigs and Fixtures

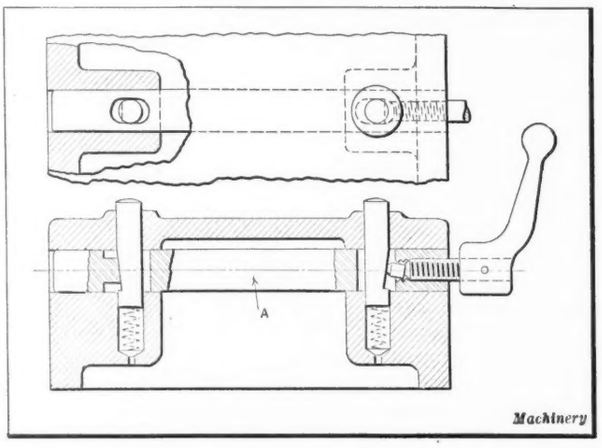


Fig. 2. Arrangement for operating Two Plungers by turning a Single Screw

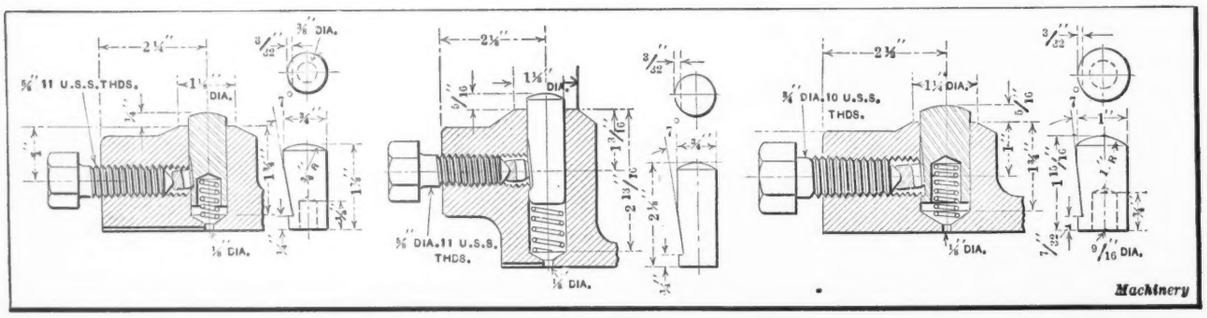


Fig. 3. Plunger with Spring placed in Hole at Lower End

Fig. 4. Size which meets Average Requirements

Fig. 5. Especially Heavy Construction for Large Work

plunger hole is reamed to a slip fit for the plunger. The coil spring is made of spring steel, 0.062 inch in diameter, and it has seven coils, an outside diameter of 19/32 inch, and a free length of 1⅜ inches. An air groove is provided from the ⅛-inch diameter vent at the lower end of the plunger hole to the outside of the fixture.

Fig. 3 shows a variant of the standard plunger construction, this being a heavier size, and in order to reduce the head room, the plunger is drilled at the lower end to accommodate the spring. The spring in this case is made of spring steel, 0.054 inch in diameter, and it has six coils, an outside diameter of 11/32 inch, and a free length of ⅞ inch. Fig. 4 shows a good size of plunger for average requirements, the spring being made of spring steel, 0.072 inch in diameter, and having seven coils, an outside diameter of 11/16 inch, and a free length of 1 5/16 inches. A specially heavy construction, intended for jigs and fixtures holding large pieces on which heavy cuts are to be taken, is shown in Fig. 5. The position of the spring here is the same as in Fig. 3. The spring is made of spring steel, 0.062 inch in diameter, and has seven coils, an outside diameter of 17/32 inch, and a free length of 1 5/16 inches.

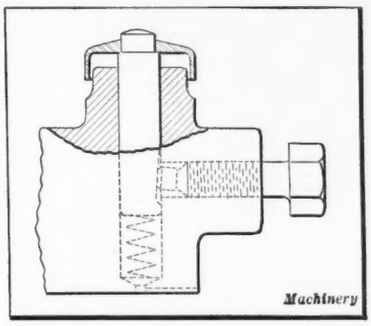


Fig. 6. Method of keeping Chips from Plunger Hole

An arrangement for clamping two plungers at one time is illustrated in Fig. 2. It will be seen that when the screw is first tightened, the clamping plug will be locked against the right-hand plunger; then, as the screw continues to be tightened, shaft *A* will be forced over, also locking the left hand plunger. Care must be taken to make the slots in the shaft of sufficient length to allow the necessary longitudinal movement. At the left-hand slot, enough stock must be milled away at the bottom of the shaft to provide clearance between the latter and the shoulder at the lower end of the flat on the plunger.

Usually the head of the plunger, on account of being under the work, is somewhat protected from chips, so that the provision of a boss, as shown in the various illustrations, is sufficient to prevent chips from working into the plunger hole. Sometimes, however, a condition will arise when chips will be thrown under the work by a cutter at some distance from the point of support, or a heavy stream of lubricant conveys the chips to the plunger. In such cases, additional protection is desirable, and the special design shown in Fig. 6 may be used. The cap on the plunger slides over the machined head of the boss, and if the fixture is so designed that the head of the boss is above the level of lubricant, the plunger cap will effectually keep out chips and prevent having the plunger jammed. If lubricant floods around the boss, its height from the base to the ridge or shoulder half way up on it should be at least ½ inch. In all cases of plunger construction, an air vent must be provided at the bottom of the plunger hole, so that the plunger can move freely. A plunger and spring must be of such dimensions that the plunger will have sufficient travel to meet variations in the work.

* * *

About forty airplane factories having a total production of 2500 machines a week were in operation in Germany at the close of the war. The majority of the firms operating these plants took up other work after the war, although three of the firms decided to manufacture airplanes for commercial use. These were the Sablatnig Co. of Berlin, the Junkers Co. of Dessau, and the Fokker factory of Schwerin.

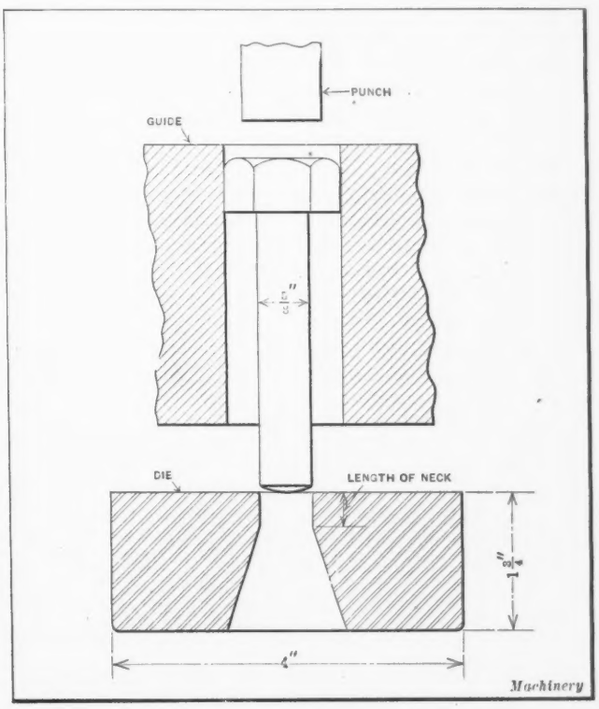
BURNISHING BOLTS IN QUANTITY

By D. C. OVIATT

A high rate of production can be obtained by finishing the bodies of bolts by burnishing instead of by grinding. As will be seen by referring to the accompanying illustration, the die employed is of simple design, as is also the guide by means of which the bolt is kept in alignment with the center of the opening in the die. The over-all dimensions of the die-block will be suitable for the size of bolt shown in the illustration, that is, ⅝ inch diameter. The length of die neck through which the bolts are forced by the punch should be equal to about half the diameter of the bolt, and should be finished by lapping and have about ⅛ inch radius at the top. Good results will be obtained from "Novo" steel, double heat-treated in the following manner: Pack-harden for three hours at 1700 degrees F., and allow to cool off in the pot; then reheat to 1300 degrees and quench in oil. The diameter of the die opening in this case is such as to reduce the diameter of the bolt 0.005 inch.

Comparison of Results Obtained by Burnishing and by Grinding

Whereas the production rate by grinding will average about 800 bolts per day, it is possible to burnish as many as 4000 bolts per day when a power press equipped with a die of the type described is employed. No trouble will be experienced in maintaining straightness of the bolts up to 4 inches long, and even then the bolts may be successfully finished in this manner. The degree of finish obtained is good, possibly superior to that obtained by grinding, and the structure of the surface, being subjected to the compressive action of the burnishing die, is harder and will wear longer than any surface which has not been treated in this way. The type of press on which this operation has been successfully performed is a No. 84 Bliss reducing press, equipped with a cam-actuated attachment for lifting the bolts out of the die after the operation has been completed. The bolts which were so finished were what is known as spring bolts and king-pin bolts, such as used on the front axles of automobiles, and they were made with an undercut under the head to take care of the metal that might accumulate on the die and prevent the bolts from seating properly.



Die used in burnishing the Bodies of Bolts

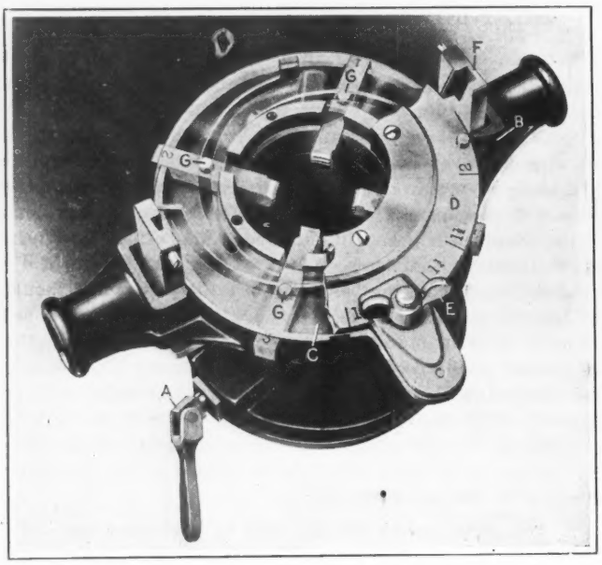


Fig. 1. Adjustable Die-stock for cutting Taper Threads on 1-, 1¼-, 1½-, and 2-inch Pipe

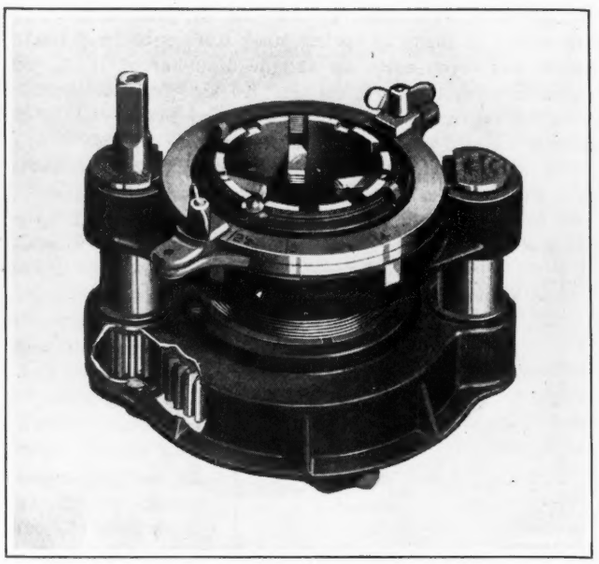


Fig. 2. Geared Die-stock for threading Pipe from 2½ Inches to 4 Inches in Diameter

Pipe Threading Tools and Their Manufacture

Methods Used in Making Beaver Die-stocks and Chasers—First of Two Articles

By FRED R. DANIELS

A MODERN type of pipe-threading die-stock is shown in Fig. 1. The die-stock is secured to the pipe by a universal chuck, tightened and released by the grip-screw *A*. The chuck-holder is threaded into die-head *B* so that as the latter is turned in cutting a thread, the chasers will be advanced at the same rate. This means that the threaded portion of the die-head must correspond in lead with that of the thread to be cut. Since the lead is the same for threads of more than one pipe diameter, it is obvious that by providing a means for opening the chasers independently to suit varying diameters, a number of pipe sizes can be threaded with the same die-stock. This is accomplished by a cam-plate *C*, in which there are slots which are engaged by pins *G* in the chasers, thus opening or closing the dies when plate *C* is turned. The dies are set to the desired pipe diameter, as determined by the graduated plate *D*, and the chasers locked in this position by wing-nut *E*. The chasers start cutting at full thread depth and travel at an angle with the center of the pipe in order to produce the standard taper pipe thread. This angular travel of the cutters is produced in the following way: On plate *D* is a lug which travels in an angular slot in post *F* as the die-head is turned in cutting a thread. The result is that the top plate advances with the die-stock, and being clamped to the cam-plate, turns that member and causes the chasers to travel at the correct angle to produce the desired taper thread, as previously mentioned. The taper-threaded chasers are not usually provided with more than two or three threads; in fact, a single chaser thread might cut a pipe thread satisfactorily under these conditions.

The die-stock shown in Fig. 1 will accommodate the four pipe diameters 1, 1¼, 1½ and 2 inches, these sizes having the same thread pitch. The use of a universal chuck for clamping the die-stock to the pipe does away with the neces-

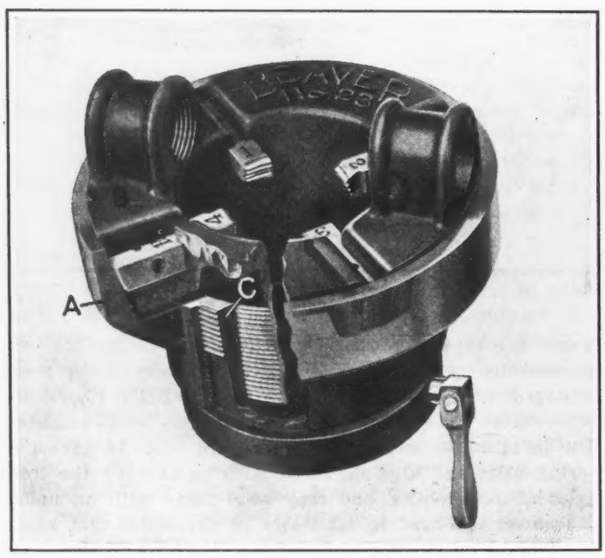


Fig. 3. Die-stock of the Non-adjustable Type

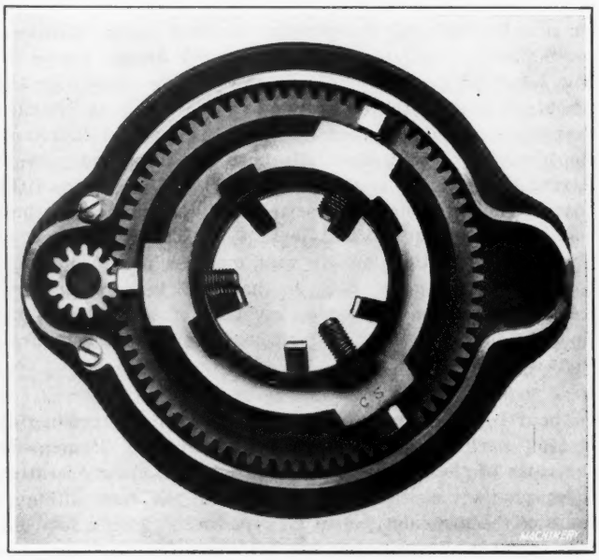


Fig. 4. Interior of Geared Die-stock shown in Fig. 2

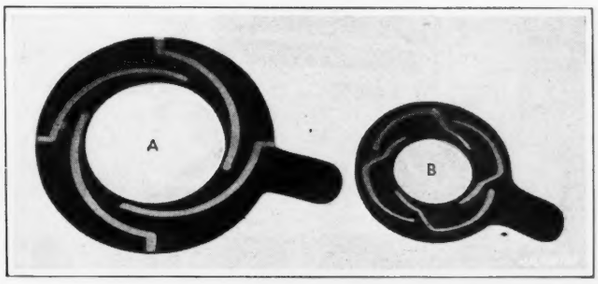


Fig. 5. Types of Chaser Cam-plates

sity of using a separate bushing for each of these sizes. The die-stocks that are described in this article are known as the "Beaver" type, and are manufactured by the Borden Co. of Warren, Ohio.

For pipe diameters of 2½ inches and larger, the die-stocks are operated by a gear and pinion, but the principle is identical with that already described. A tool of this construction that will handle pipe sizes up to 4 inches is illustrated in Fig. 2. Aside from the geared feature and the pillar arrangement for keeping the upper and lower main members in alignment, this die-stock is the same in principle as the one used for the medium sizes of pipe.

Die-stocks with Two Sets of Chasers

For the small sizes of pipe, when it is necessary to handle more than one diameter, the construction previously described must be modified. This is due to the fact that the pitch varies more in the smaller sizes than in the larger sizes. For example, a ¼-inch and a ⅜-inch standard pipe thread have eighteen threads per inch, and a ½ and a ¾ inch thread have fourteen threads per inch, whereas, the thread pitch on larger sizes of pipe would be the same for a number of consecutive sizes. By making provision for accommodating two sets of chasers, these four pipe diameters can be threaded with one tool. A die-stock of this type must be so designed that while one set of chasers is in use the other set can be withdrawn from contact with the pipe. The principal change in design made necessary by this requirement is in the slots of the cam-plates which control the radial adjustment of the chasers.

The difference in cam-slot arrangement is clearly shown in Fig. 5, the cam shown at *A* being the type used when one set of chasers is employed, and that at *B* the type used when more than one set is employed, and it is necessary alternately to advance and withdraw the sets of chasers, as when threading the smaller pipe sizes.

Non-adjustable Type of Die-stock

A die-stock which is not adjustable is illustrated in Fig. 3. This tool is of simpler construction than the cam-plate type, and consists of only three main parts in addition to the die chasers. In this case, the chasers are set to the required pipe diameter when the top edge of the outer housing *A* is flush with the upper surface of the die-head *B*. The barrel of the die-head is threaded externally, the threads having the same pitch as the thread to be cut. The threaded part of the head operates in the leader nut *C*, the outside of which has a coarser thread than that of the die-head barrel so that as the die-stock is turned, the outer housing will advance at a faster rate than the die-head. Consequently, the chasers will be traversed at the required thread angle due to the angularity of the inner wall of the outer housing against which the ends of the chasers bear. With a die-stock of this type it is necessary to use separate sets of chasers and bushings for each size of pipe that is threaded. The principal feature of this stock is its low cost due to the small number of parts entering into its construction.

Examples of Machining Operations

The housings for the operative parts and the slots in which the chasers are seated must be correctly machined, and the surfaces must be in a definite relation to each other if ease of operation and a high quality product is desired. The machining of the leader nut for the type of die-stock shown in Fig. 2 is of interest. This leader nut has gear teeth cut on its periphery, as shown in Fig. 4, which is a view of the bottom of the die-stock, showing the chasers and the construction of the pinion-shaft case in which the pinion and the gear end of the nut are housed. The machining operations to be described are performed on a Potter & Johnston turret lathe, Fig. 6. The work is held in a chuck provided with soft jaws. The tools carried in bar *A* rough-bore the two diameters *B* and *C* of the work. The bar is long enough to enter a guide bushing in the chuck and thus insure concentricity between the two bored diameters. While the second tool is at work, two tools in holder *D* rough-turn the flange of the work. This flange has two diameters separated by recess *E*. Before these two rough-turning operations are completed, tool *F* chamfers the inside of the hole.

The boring-bar used at the second station of the turret also comes into alignment with a bushing in the chuck and carries two finishing tools *G* and *H* for finish-boring the previously rough-machined holes while the shoulder is being squared up by tool *J*. At the same time the outside of the flange is beveled by means of tool *K*. Surfaces *L* and *M* are then rough-faced by a pair of tools mounted at the rear of the cross-slide and finish-faced by another pair of tools at the front of the cross-slide. Recess *E* is turned by tool *N* carried in a tool-block which is attached to the cross-slide in such a position as to turn the recess at the same time that surfaces *L* and *M* are being faced. The final machining operation consists of tapping the hole in the flange with a self-opening die-head *O*, which is mounted in the third station of the turret.

In finishing the outside diameter and the opposite side of the leader nut in another Potter and Johnston machine, the work is held by soft expanding jaws which grip it in the previously tapped hole. The chuck also has a pilot for locating the piece centrally with respect to the turret lathe spindle. The operations performed in this machine are rough- and finish-facing the opposite side of the nut and rough-turning the outside diameter. While these operations are in process, the rough edges are removed by auxiliary tools.

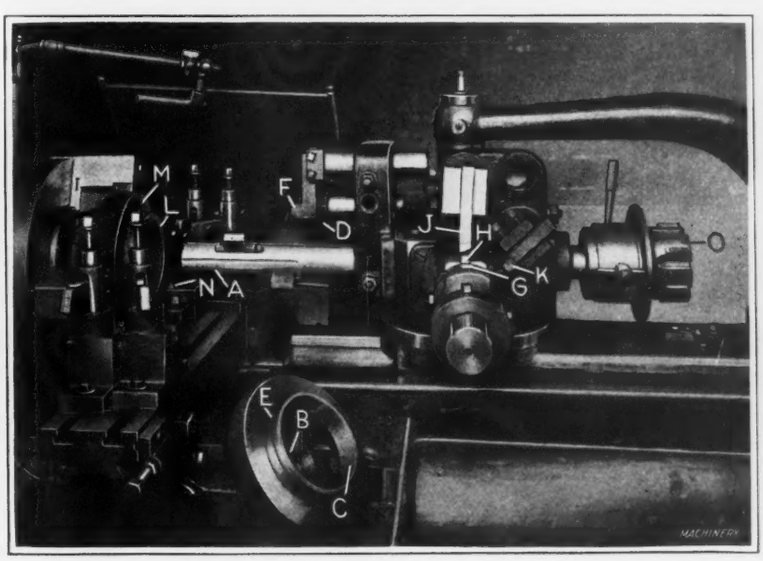


Fig. 6. Turret Lathe equipped with Tooling for machining Leader Nuts for Pipe Thread Chasers

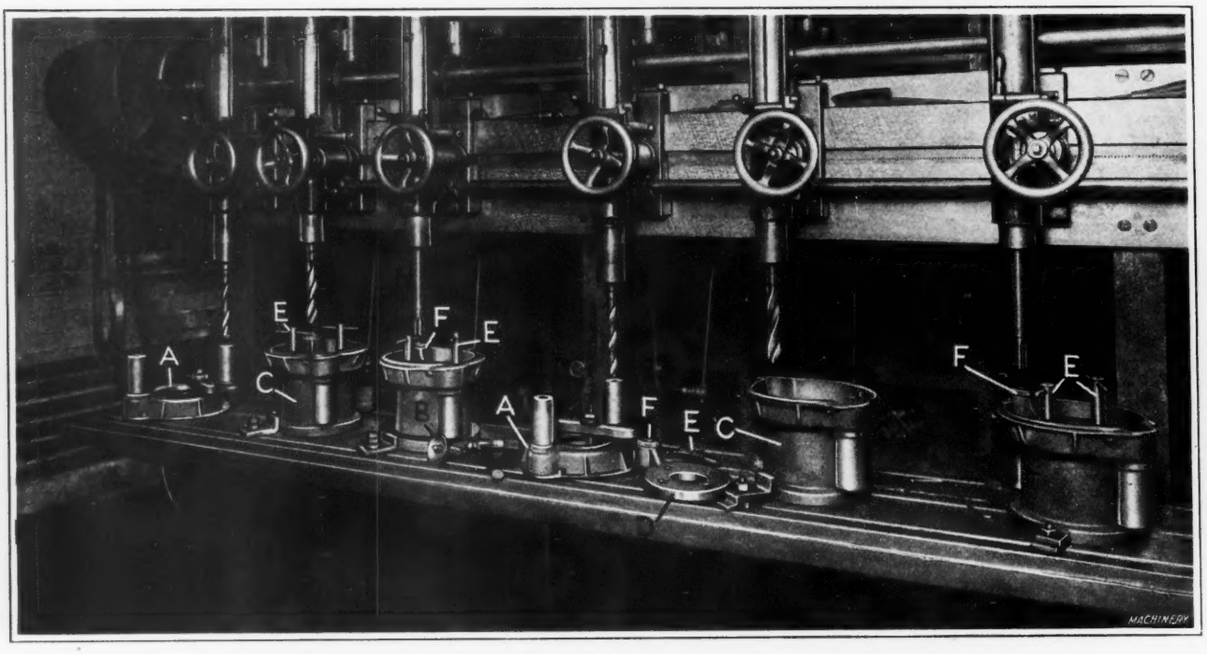


Fig. 7. Multiple-spindle Drilling Machine arranged for drilling Hole in the Pinion-shaft Case

The pinion-rod hole in the pinion-shaft case, Fig. 4, is machined on a Foote-Burt multiple drilling machine, as illustrated in Fig. 7. Two gangs of tools are used, each of which consists of two drills and a reamer, so that steady production can be maintained without undue loss of time by the operator. The work is shown strapped to the machine table at *A*. The outside diameter of the post through which this hole is drilled is previously machined, so that by using the prick-punch *B* for locating the center for the 7/8-inch drill which is used first, it is not necessary to use a fixture for this operation. As soon as this hole has been drilled, the operator unclamps the work and loads it into jig *C*. The jig is of the pot type, with a shoulder for receiving the work. The height of this shoulder is less than the thickness of the casting, leaving a pocket, 1/4 inch deep, in which the jig plate *D* fits, where it is located by dowels and secured by pilot-screws *E*. This brings the bushing *F* into correct relation with the center hole in the case.

The 1 7/32-inch drill used in the second spindle is fed at a higher rate than it would be if the preliminary drilling operation had not been resorted to. By this means it is possible to so regulate the feeds of the two drills that no idle time results. As soon as the drilled piece is removed from the second spindle position, it is located in a similar jig, and reamed by a 1 1/4-inch reamer in the third spindle. While the three tools are operating, the attendant is busy at the other three spindles of the machine, after which it is time to return to the opposite end and start over again. The jigs are not fastened to the machine table, but are located by straps attached to the table; one of these prevents the jig from turning by abutting against a foot projecting from the base of the jig, and the other acts as a locating point at the front of the jig.

Machining Chaser Slots in Die-stock Heads

It is very important to have the chasers accurately fitted in the die-heads, and great care must be exercised in laying out the slots in the cam-plate by means of which the chasers are opened and closed. The practice in machining the malleable iron die-head castings for the accommodation of the chasers, is to first rough-mill them and then to finish the slots by broaching. Broaching has been found to give the desired degree of accuracy. In Fig. 8 is shown the set-up of a Lapointe broaching machine for finishing the slots in the type of die-head illustrated in Fig. 3. The work *C* is located on a special fixture *D*, which is attached to the head of the machine. In the illustration broach *A* is shown located in guide *B*, as it would appear near the end of the broach travel.

Another type of broaching fixture which will accommodate four small die-head castings is illustrated in Fig. 9. In this case, broach *A* rides on its back on bar *B*. The work is

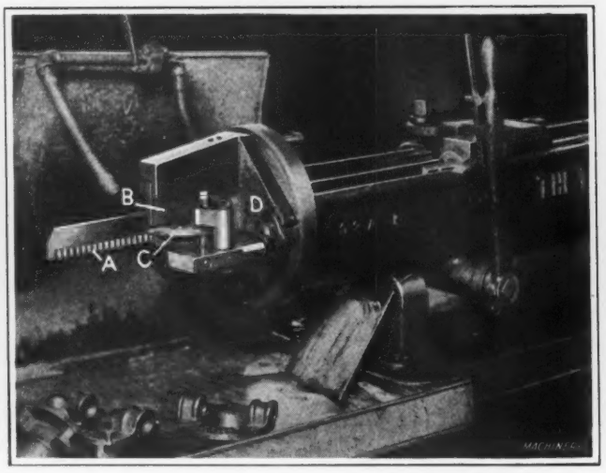


Fig. 8. Broaching Chaser Slots in Die-heads of the Type shown in Fig. 3

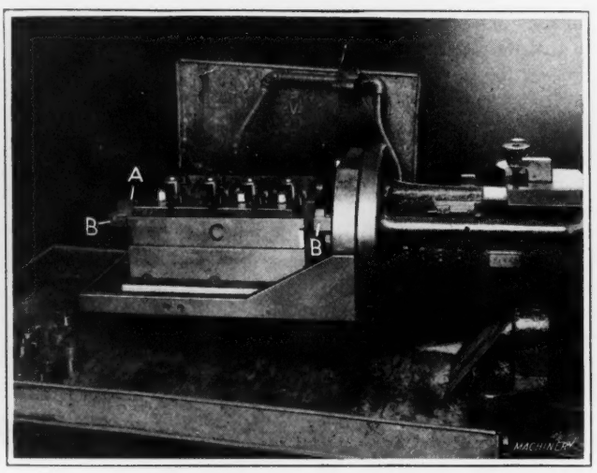


Fig. 9. Broaching Chaser Slots in the Smaller Die-heads, using a Gang Fixture

clamped in an inverted position in fixture *C* so that the cut is up. These die-heads are also milled previous to broaching, and the broaching fixture is arranged so that when it is clamped in position the milled slots align with the broach. Small die-heads like these are for use on die-stocks employed for threading the very smallest sizes of pipe. An unusual feature of the broaching fixture shown in Fig. 9 is its massive size for such a small piece of work. This heavy construction, however, provides the necessary support for the broach to maintain the required accuracy.

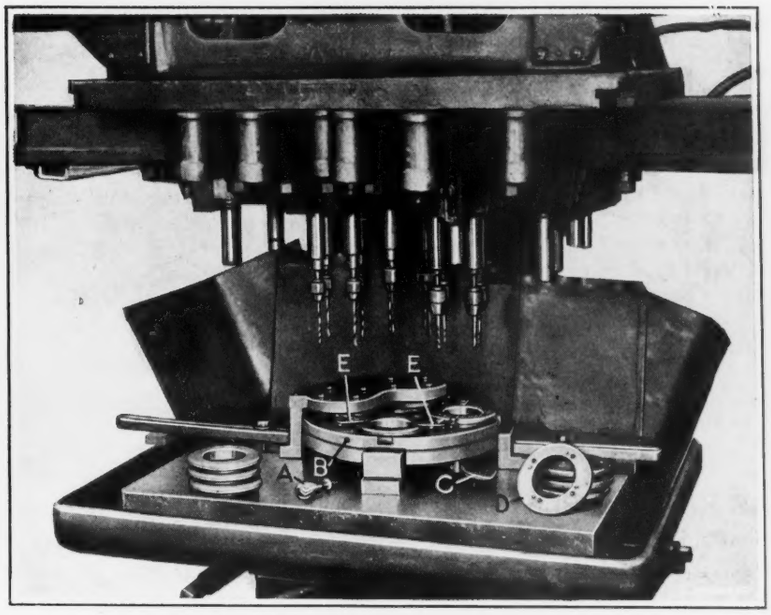


Fig. 10. Multiple-spindle Drilling Machine of the Cluster Type, and Indexing Jig used in drilling Chaser Cam-plates

Before the cam-plate slots, Fig. 5, can be milled, a preliminary drilling and counterboring operation is performed on the "Natco" multiple drilling machine illustrated in Fig. 10. The holes thus produced are for starting the end-mills used in cutting the slots. The indexing type of drill jig used for this work accommodates four chaser cam-plates, and can be indexed from station to station by inserting the removable handle *A* in hole *B* of the revolving jig plate after latch *C* has been depressed. There are three clusters of tools, two of four drills each, and one of four counterbores. These are all working at once while the operator is loading and unloading the fourth station. A number of the unmachined plates are shown lying on the machine table, and one which is partly drilled and counterbored may be seen at *D*. The work is held on the indexing jig plate by two flat springs *E* which are attached to the plate by a screw at the center so that they can easily be raised from the work and swung to one side when unloading. There is sufficient tension in these springs to prevent the work from changing position during the drilling operation.

Milling the Cam-plate Slots

In milling the pin slots in these chaser cam-plates a special duplex end-milling machine, designed and constructed by the Borden Co., is employed. This machine is illustrated in Fig. 11. The machine has an ordinary worm and worm-wheel feed mechanism on each end. The faceplates *C* on which the work is mounted are revolved by master cams *A* and *B* to produce the special form of cam slots. An end-mill *D* of the proper diameter is used in taking the cut. The procedure is as follows:

After attaching the cam-plate *W* to the faceplate of the machine by the aid of a central locating stud *E* and suitable clamps, the operator advances each carriage against stops *L* until the end-mill enters one of the previously counterbored starting holes. The carriages are traversed by the hand-levers *M* to bring them against the stops. The feed is then engaged by raising the worm-handle *F*, and a combined radial and rotary movement of the faceplate is obtained by the engagement of a cam-roll in slot *N* of the master cam. This cam-roll is attached to the end of the bearings *G*, and always remains in engagement with the slot in the master cam.

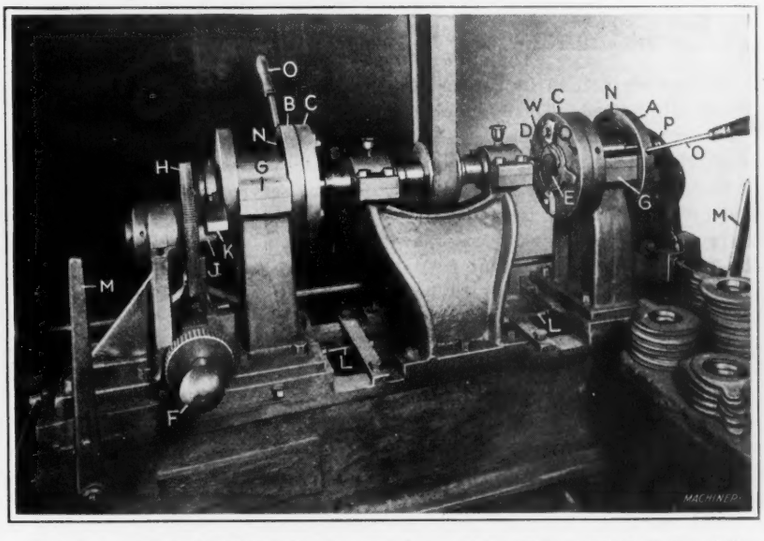


Fig. 11. Special Duplex Milling Machine used for machining Slots in Die-stock Cam-plates

Obtaining Variable Rotary Feed

A rather ingenious arrangement has been employed in this machine for obtaining a variable rotary speed in feeding the work past the end-mills. This variation in speed is necessary because of the design of the slot, it being evident that at the central section of the slot the direction changes from approximately a concentric path to an abrupt angle, which is almost radial in direction (see cam *B*, Fig. 5). The variation in rate of feed is accomplished by mounting the feed worm-wheel *H* eccentric relative to the center of the faceplate of the machine and below it. There is a dog *J* on the inside of the worm-wheel, by which the faceplate is driven through the medium of lever *K*, which is fixed to the faceplate shaft. The relative position of the centers of the worm-wheel and of the faceplate is such that when the abrupt change in direction of the path is reached, the driving dog *J* will travel toward the center of the faceplate on the lever *K*, and so the angular movement of the driver will transmit to the faceplate a greater rotary movement when driving from this position than when the lever arm from the center of the dog to the center of the faceplate is longer. To express it in another way, the lever arm of the driver is shortened, which results in a greater movement at the circumference of the faceplate. At the end of this abrupt change in path, it is necessary to resume a slower rate of feed, and the relation of the driving dog to the center of the faceplate permits this to be done by again increasing the length of the lever arm of the driver.

At the termination of one slot, the feed knocks off and the operator turns the master cam back-

ward by means of handles *O* so that the cam-roll is again at the beginning of the slot. The two carriages are slid away from the end-mill sufficiently to enable the faceplate to be indexed through an arc of 90 degrees preparatory to starting the second slot. The index-pin and bushing are shown at *P* and *Q*, respectively.

On the types of cam-plates in which the slots follow a more uniform cam curve (as cam *A*, Fig. 5) machines of the same type are used, but in this case it is not necessary to employ a master cam, the cam-plates simply being mounted eccentrically relative to the center of rotation of the faceplate.

The second article on the manufacture of pipe threading dies, which will be published in June MACHINERY, will contain a detailed description of the operations employed in manufacturing the thread chasers, the heat-treating and inspection practices, and the device used in registering the amount of pull required in threading a pipe.

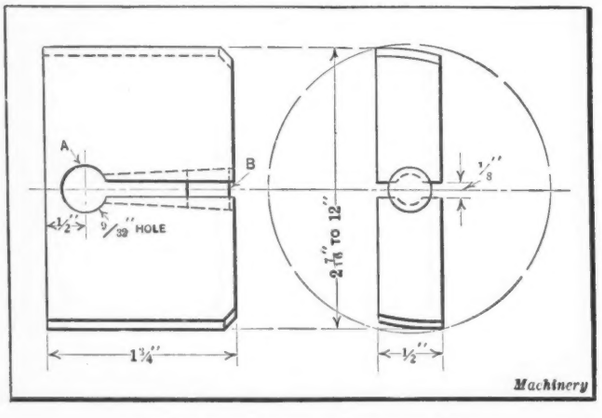
* * *

ADJUSTABLE REAMER BLADE

By LOUIS J. KESSLER

The writer read with interest the description of a new style of adjustable reamer blade, which appeared on page 231 of November, 1921, MACHINERY. Another adjustable reamer blade of somewhat different construction, which is used in the plant where the writer is employed, is described in the following. The cutters range in size from 2 7/16 inches up to the large blades used for reaming holes 12 inches in diameter. They are referred to in the shop as "floating double-end cutters" and all sizes are made adjustable within certain limits. Annealed flat high-speed steel stock ½ inch by 1¾ inches is standard for making all sizes.

The adjustable feature will be apparent from an inspection of the illustration. After the cutters have been turned about 0.015 inch over size, a 9/32-inch hole is drilled at *A*.



Floating Reamer Blade of Adjustable Type

A hole for a No. 5 taper pin is then drilled in the end of the cutter so that it will break into hole *A*. The ⅛-inch slot shown in the illustration is then cut in the blade.

After being hardened, a short taper pin *B* is driven into the tapered hole just tight enough to prevent it from falling out. The cutter is then placed on an arbor held between centers on a grinder and ground to size and relieved. The width of the cutter at the back end is made about 0.0015 inch less than the width at the front or cutting end. When worn so that it cuts under size, the cutter can be readily expanded by driving in tapered pin *B*.

This style of cutter has been in use for several years on boring mills, lathes, and drilling machines for reaming operations on all kinds of materials. The bars in which the cutters are held must always be properly centered or aligned with the holes being reamed. Not more than 0.005 inch on the side of a hole should be left for reaming. The maximum amount of expansion obtainable with this type of cutter is approximately 0.030 inch.

SIMPLIFIED FORMULA FOR STRENGTH OF GEAR TEETH

By DAVID T. MALPARTIDA

The formulas given in this article make it possible to determine directly the diametral or circular pitch for a gear when the horsepower to be transmitted and the velocity in feet per minute at the pitch diameter are known.

On page 595 of MACHINERY'S HANDBOOK this formula is given:

$$W = \frac{SAY}{P} \qquad (1)$$

in which

W = maximum safe tangential load in pounds at pitch diameter;
S = allowable unit stress for material at given velocity;
A = width of face in inches;
Y = outline factor for Lewis formula (as applied to diametral pitch); and
P = diametral pitch.

Let P_1 = circular pitch $= \frac{3.1416}{P}$, or $P = \frac{3.1416}{P_1}$

Inserting this value in Formula (1), we have:

$$W = \frac{P_1SAY}{3.1416}$$

But A (the width of face) is usually a certain number of times the circular pitch; so that we may write $A = kP_1$, where k generally is from 2 to 3 for cast teeth gears. Then

$$W = \frac{P_1SkP_1Y}{3.1416} = \frac{P_1^2SkY}{3.1416}$$

From this it follows that

$$P_1 = \sqrt{\frac{3.1416W}{SkY}}$$

But $W = \frac{33{,}000 \text{ H.P.}}{V}$ (see page 595, MACHINERY'S HANDBOOK) in which V = velocity in feet per minute at pitch diameter. Hence,

$$P_1 = \sqrt{\frac{3.1416 \times 33{,}000 \text{ H.P.}}{SkYV}} \qquad (2)$$

To obtain the diametral pitch P, substitute $\frac{3.1416}{P}$ for P_1 in Formula (2) and solve for P:

$$P = \sqrt{\frac{3.1416SkYV}{33{,}000 \text{ H.P.}}} \qquad (3)$$

For cut teeth gears, k is generally from 3 to 4.

For gears with cast teeth, the writer uses the following values for the static unit stress S_s:

Cast iron, 4000; phosphor-bronze, 6000; 0.30 carbon steel, 7500; 0.50 carbon steel, 12,500; steel (average) 10,000 (all in pounds per square inch).

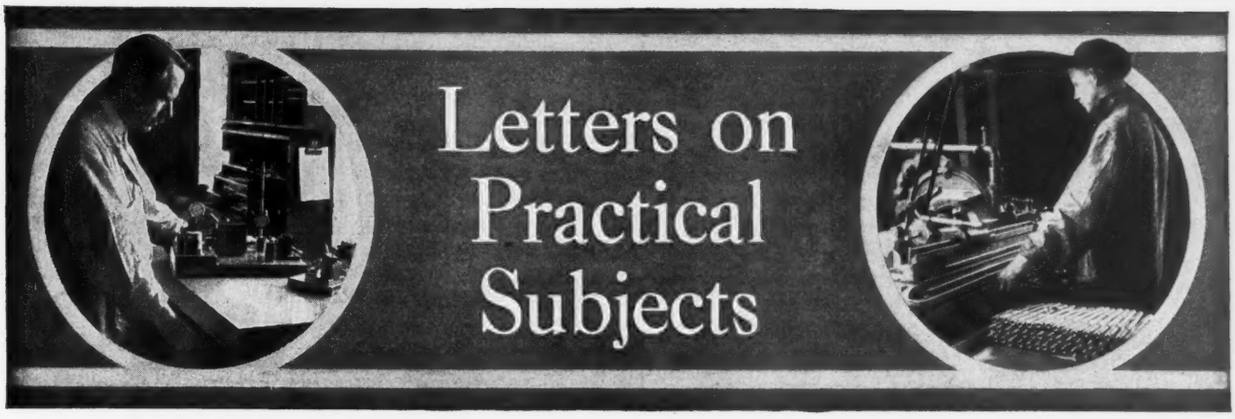
These values apply to steady load conditions; for intermittent service, use from 50 to 75 per cent of these values.

From these values S can be found as follows:

$$S = S_s \times \frac{600}{600 + V}$$

* * *

According to index figures of prices collected by Dwight P. Robinson & Co., engineers and constructors, New York City, if the price index for 1914 is assumed as 100, the index figure for January, 1922, for metals and metal products is 117. The average of all commodities is 148, showing that the metal-working industries have reduced their prices far below the average of the industries in general. Building materials have an index figure of 202, one of the highest on the list.

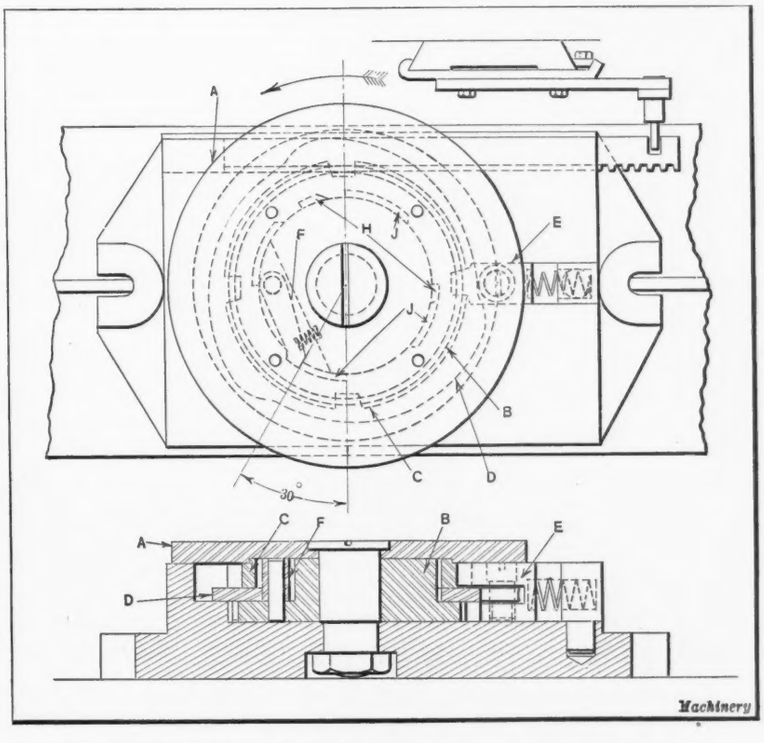


INDEX MILLING FIXTURE

An indexing milling fixture which may be used either on a hand- or a power-fed milling machine is shown in the accompanying illustration. This fixture is of simple design and positive operation. It lends itself to a rather broad application, although it is not recommended for an index movement of less than 45 degrees. The illustration shows the fixture as arranged for a 90-degree index movement. The special use for which an equipment of this kind is recommended is in the milling of a large number of small pieces, where a considerable amount of time may be saved by clamping four holding devices on the fixture plate *A*. By this means high production may be obtained, utilizing the fixture as in station milling, one side being loaded while the holding device at the opposite side is at work.

The construction and operation of the device are as follows: A stationary rack is connected to the column of the machine and is capable of adjustment for position relative to the machine spindle. The backward movement of the machine table causes the gear *B*, which is loose on a central stud, to rotate in the direction indicated by the arrow. The gear is cut out to accommodate a spring pawl *F*, by means of which movement is imparted to the index-plate *C* and thence to the fixture plate *A*. The index-plate is attached to the fixture plate, and in this case contains four notches *J*. The outer periphery of the plunger plate *D* is a three-lobe cam which operates the spring plunger *E*, and permits the indexing movement of the fixture to take place.

In the illustration the fixture is shown just prior to the backward movement of the table after the cut has been taken. Pawl *F* engages one of three notches *H* in the plunger plate, and as the gear is rotated this plate is moved through 30 degrees, withdrawing plunger *E* from the notch in the index-plate at which time the pawl also engages one of the four long notches *J* in the index-plate. Continued rotation of the gear from this point turns the index-plate 90 degrees, when the plate is again locked in place by the plunger. During the forward movement of the table and while the cut is being taken, the index-plate remains locked by the plunger. The 30-degree reverse table travel before the index movement occurs, is for the purpose of preventing pawl *F* from again coming into the indexing position until the table has carried the work backward for enough to clear the cutter.



Indexing Milling Fixture for Use in milling a Large Number of Small Pieces

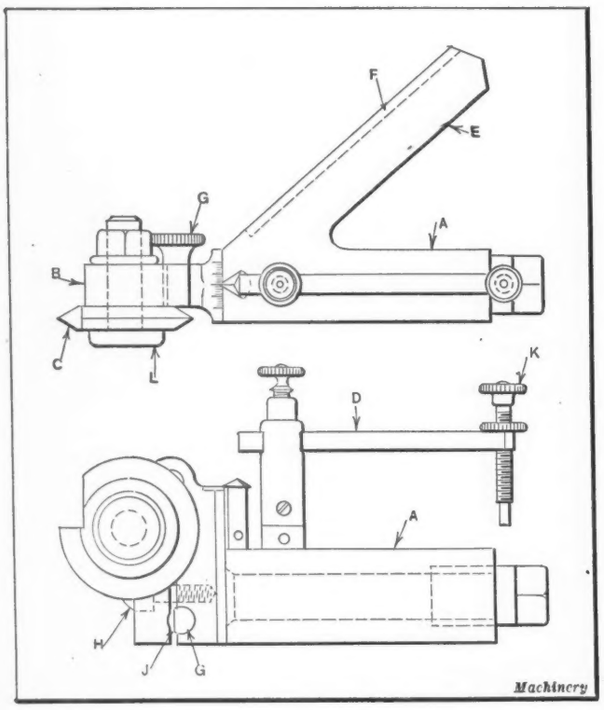
As previously mentioned, the design may be modified to suit different cases, but the main points in the construction are that the index-plate must be fastened to the fixture plate and that the plunger plate must have one less cam rise than there are index movements.

Fitchburg, Mass. E. E. LAKSO

THREAD-CUTTING TOOL

In the following is described a thread-cutting tool designed by the writer with the object of combining some of the most desirable features found in different types of thread-cutting tools. Although this tool has now been in use for a number of years the writer has yet to find its equal for ease of manipulation or for accuracy. The tool is composed of the following parts: A block or holder *A* which fits the lathe toolpost; a swivel head *B* which holds the cutter *C* and allows it to be set at any angle within its range; and a swinging gage-bar *D* with an adjustable stop *K* which is used to set the cutter in its proper position after it has been ground.

The part *A* is a piece of machine steel finished accurately to the shape shown. A dovetail slot cut in the side of arm *E* holds a data plate *F* which can be made to suit the class of work for which the tool is generally used. The part *B* is made from tool steel, finished to size and graduated in degrees. This piece is hardened and drawn to a spring temper. The cutter *C* can be counter-



Thread-cutting Tool

sunk on one side to allow a countersunk head bolt to be employed, if desired, so that the tool can be used for cutting threads close to a shoulder. The cutters are hardened and drawn to a light straw color, after which the bolt holes are lapped to size. After the holes are lapped, the cutters are placed on an arbor and ground accurately to the correct form for thread-cutting.

By means of button *G* and adjusting screw *H* the holder can be adapted for use either as a spring or a solid tool. When used as a spring tool, the flat side on button *G* is brought parallel with the slot in part *B*, leaving an opening of about 1/16 inch at *J*, and thus allowing the spring in the upper part of *B* to act. When in use as a solid tool, the flat surface on button *G* is turned at right angles with the slot in part *B* and adjusting screw *H* tightened. Part *B* is graduated in degrees to read in both directions as shown, thus allowing the cutter to be set to correspond with the helix angle of either right- or left-hand threads.

The gage-bar *D* and adjusting screw *K* are of great assistance when the point of the tool breaks, as it is a simple matter to loosen the nut on screw *L*, remove the cutter and grind it, after which it can be set back in the same position without removing the work from the lathe. By swinging bar *D* around and using the lower end of screw *K* as a stop, the cutting point of tool *C* can be located at the proper height. The plate *F* is marked to give the diameter of screw, number of threads per inch, angle of thread, and also total depth of thread. This has proved a convenient method of presenting these data, and as many slides are made up as are required to cover the range of threads likely to be cut. When setting the tool in the lathe, a parallel is first placed between the faceplate and the side of the holder, after which the cutter is adjusted for height.

Chicago, Ill. A. H. Wilson

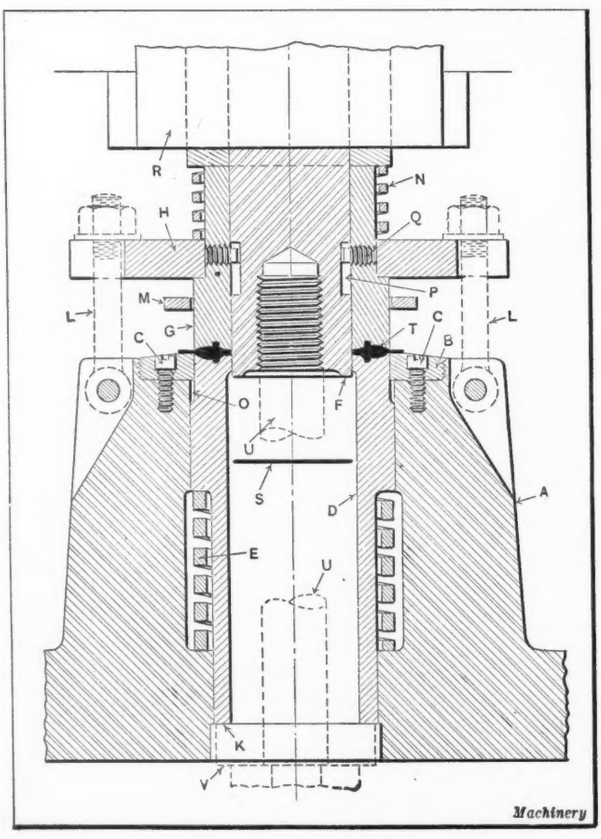
TRIMMING DIE FOR SMALL FORGINGS

The accompanying illustration shows a trimming die for removing the fin or flash from cycle free-wheel ring forgings in one operation. This die has a cast-steel bolster *A* into the top of which is screwed the hardened external trimming ring *B*. Two fillister-head screws *C* are inserted in ring *B* to prevent it from working loose. The punch *D*, which is made of special punch steel, serves as an extractor and also forms the ring for punching out the center part *S* of the forging.

On the up stroke the spring *E* actuates punch *D*, causing the forging *T* to be extracted from ring *B*. The center punch *F* is also made of special punch steel and is hardened and ground. This member forms a center which locates the sliding punch *G*. There is a shoulder on the outside diameter of punch *G*, on which flange *H* rests. It is necessary to provide a stripper *M* for the outer flash. Spring *N* acts on punch *G* through flange *H*.

The operation of the tool is very simple, and it is well adapted for use on a single-acting press. Referring to the illustration, it will be noted that the center of the forging has just been punched and that the fin is falling through the hole in punch *D*. As the ram of the press continues its downward stroke, punch *G* will clip the outer part of the forging. On the return of ram *R*, stripper *M* removes the fin from punch *G*. Punch *D*, actuated by spring *E*, follows the up stroke of the press until the shoulder at *O* strikes the bottom of the trimming ring *B*. Ram *R* continues its upward stroke carrying with it punch *F*.

Punch *G*, through the action of spring *N*, will remain down until punch *F* has moved upward a sufficient distance to bring the bottom of the slot *P* into contact with the screw *Q*. This enables ram *R* to open the dies so that the finished forging can be taken out. It should be noted that punch *G* and extractor *D* are both formed at the ends to fit the forging. This is necessary to prevent any distortion of the forging, which is of very light weight and is required to be kept within close limits of accuracy, only 1/32 inch being allowed for finishing. Center punch *F* is threaded for an extractor bolt *U* (shown in dotted lines) on which is placed a mild steel washer *V*, which rests on the end of punch *D* at point *K* when the bolt is employed to release the dies. It will be noticed in the illustration that two swinging bolts *L*, shown by dotted lines, are fitted into slots cast into bolster *A*. When the dies become worn, they occasionally stick in ring *B*. The extractor bolt is then screwed into the punch *F*



Die for trimming Flash from Small Forgings

from beneath the press table. The bolt thus clamps the parts *R*, *F*, *G*, and *D* together as one piece. The dies are then released by turning the flywheel by hand. To release a forging in case it becomes stuck on punch *F*, it is only necessary to swing the bolts *L* into slots cut in flange *H* so that the punch can be readily withdrawn.

Cleveland, Ohio C. F. GEORGE

CONNECTING-ROD BORING AND REAMING FIXTURE

The fixture shown in Fig. 1 was designed to perform the finish-boring and final reaming operations on a connecting-rod crankshaft bearing. It insures a bearing of accurate size and one that is parallel and square with the wrist-pin bushing hole. The connecting-rod *A* is held on the wrist-pin end by means of a spring collet *B* actuated by the screw *C*. On the crankpin end it is held by the sliding arbor *D* which locates it, prior to clamping, by the forked clamp *E* actuated by the screw-operated tapered wedge *F*.

The arbor *D* is hollow and has a hole ground at the connecting-rod end to take the end of the reamer-bar *H*. It also has a stop-pin *G* at the other end so that there will be no chance for the workman to force the connecting-rod over the small shoulder on the arbor; this shoulder is necessary because the bushings in which the arbors *D* and *H* slide are made large enough to let the reamer and cutting tools through. The left-hand end of reamer-bar *H* is made to fit into a "Magic" chuck, and the right-hand end is provided with a pilot and a standard shell reamer taper to take the reamer shown in Fig. 2.

The reamer is composed of a shell carrying a single fly tool *K* on the front end, which bores the bearing to within 0.003 inch of the required size. At the back of this reamer are inserted eight duplex reamer blades, one of which is shown at *L*. Each of these blades is 1 inch long and set at a 5-degree angle with the axis to form a left-hand spiral reamer. This reamer produces a fine finish and a very accurate hole.

The body of the fixture is made of cast iron and is well ribbed. It can be set up in a lathe or on a horizontal boring machine. When in operation, the connecting-rod is inserted while the reamer is pulled back. After the rod is in place

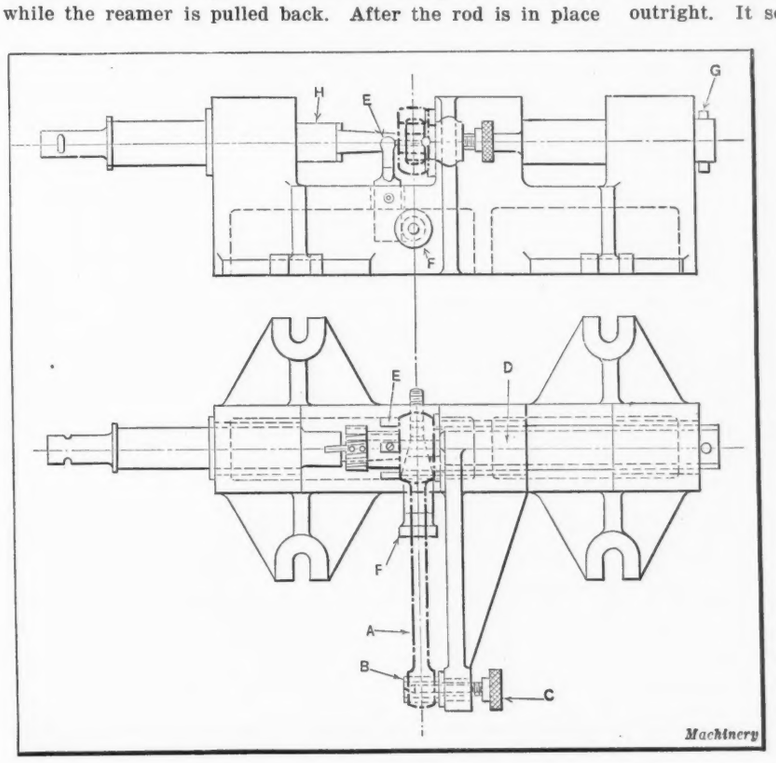


Fig. 1. Boring and Reaming Fixture for Connecting-rod Bearing

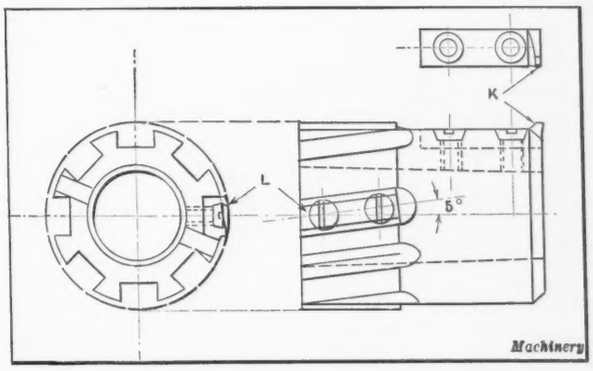


Fig. 2. Combination Boring and Reaming Cutter used in Fixture shown in Fig. 1

the reamer is fed up while being rotated at a very high speed. Compressed air is used to blow the chips away from the cutting edges of the tool.

Pittsburg, Pa. WILLIAM OWEN

LISTS FOR CHECKING DRAWINGS

A list as an aid in checking drawings has been tried out at one time or another in nearly every drafting-room. Checking lists are very good in principle, but in practice it is usually found that the checkers lay them away as soon as the novelty has worn off. One firm has insured daily reference to its checking lists by providing blank spaces to the right of each item on the list. The drawing number is entered at the head of the column and as each item is checked, a mark is made in the proper space.

When the checking is completed, the check list and drawings are turned in to the chief draftsman. The improvement in the quality of checking which was noticeable when checking lists were first introduced in this drafting-room has been maintained, although the lists have been in use for more than eight months. The two check lists adopted (one for lay-out and one for detail drawings) were compiled after a study of several representative ones. The scope of the lists examined varied widely and none of them could be adopted outright. It seems to be necessary for each drafting-room to make its own checking list to suit local conditions.

The lists finally adopted, which proved satisfactory in this particular instance, are given here simply to illustrate the general nature of the checking system. After the lists were prepared, they were carefully traced and blueprint copies furnished to the checkers. At the head of the lists a space was left for the name of the checker and the date. It will be noted that the various items in the check list for lay-out drawings are arranged in groups; for instance, in the first group there are only two items, namely, the drawing number and the original data, while in the third group there are ten items, including the group heading and the subheadings.

The check list for lay-out drawings included the following items in the order given:

1. Drawing number; original data.
2. Design, including (a) rigidity; (b) strength; (c) formulas; and (d) numerical work.
3. Practice, including (A) finish, under which are given the items (a) limits of accuracy necessary, and (b) use of finish pads; (B) methods of fastening, with reference to bolts, studs, cap-screws, etc., and their (a)

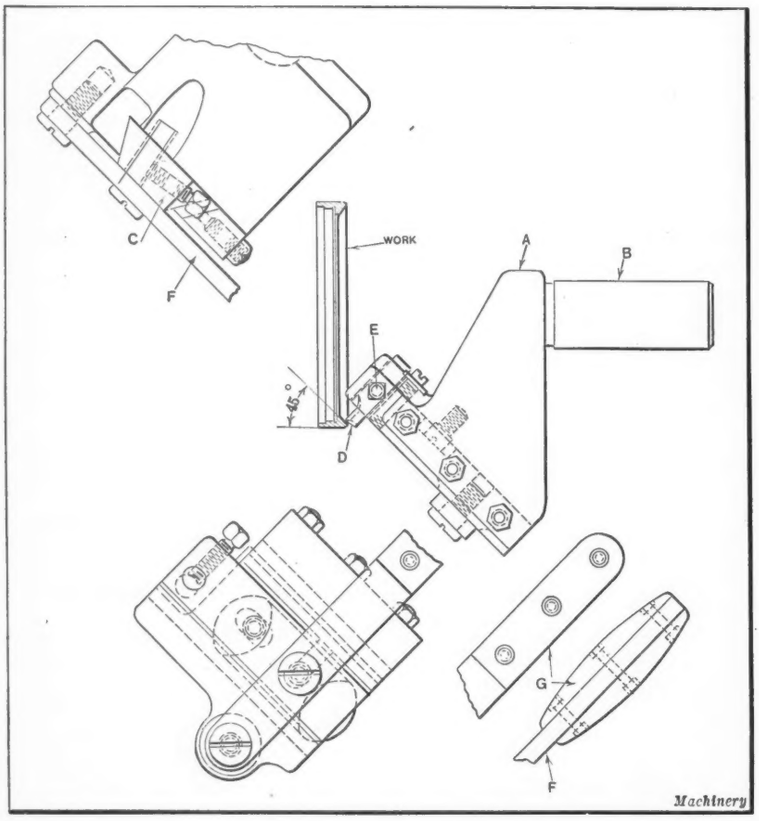


Fig. 1. Auxiliary Cross-slide designed for turning a 45-degree Taper

position; (b) size; (c) number; (d) removable with standard wrenches; and (e) clearance provided for bolt-heads and nuts.

4. Ease of manufacturing parts with reference to: (A) molding, including (a) fillets of sufficient size; (b) draft; and (c) cores; (B) forging, with reference to (a) machining, (b) use of jigs and fixtures, (c) use of standard sizes and standard parts, and (d) use of old parts, patterns, etc.

5. Interference, with reference to: (a) assembly checked with detailed drawings, and (b) operation of machine from checking assembly drawings.

6. Operation with regard to (a) simplicity, (b) ease of adjustment, (c) ease of repairing, and (d) provision for proper lubrication.

7. Check drawings with drafting-room standards.

The items to be checked as given on the check list for detail drawings, were as follows: Drawing number; neatness and clearness; crowding; lettering; center and section lines; projections correct; drawn in relative assembled position; drawn to scale; all necessary dimensions given; dimensions repeated; finish marks; limits; notes; name; number of pieces required; material specification and treatment; drawing, pattern and piece numbers; initials, date and scale; use of a part already made; standard parts and sizes; easily machined and molded; checks with component parts; how fastened in place; easily assembled; interference of moving parts; interference in assembly; lubrication; check with drafting-room standards; index card; drawing checked.

SPINNER

AUXILIARY CROSS-SLIDES FOR TURRET LATHES

The special turret tools shown in Figs. 1, 2, and 3 were designed for the purpose of providing a more sensitive feed and stop than is possible with the standard style of box-tool, boring tool, or facing tool, and at the same time affording a means of obtaining greater production through the provision of a lighter and therefore faster means of feeding the cutter. Too often a large heavy turret is employed when taking a comparatively light cut, the work being placed on the large machine because of its size or the nature of other operations that are to be performed.

An example of this class of work is shown in Fig. 1. The large diameter of the work in this case made it necessary to use a machine as large as a No. 2 Brown & Sharpe or a No. 2 Warner & Swasey hand screw machine. The cast-iron holder *A*, with its shank *B* cast integral, is provided with a gibbed dovetail slide *C*. The cutter *D* is made from round tool steel, and is retained in the slide by a set-screw *E*. The slide is operated by the lever *F*, the handle of which is shown at *G*.

The accuracy obtained by the use of this tool in finishing the work to the required 45-degree angle was greater than that resulting from the use of a formed blade held in a regular box-tool holder. The expense for cutters was also considerably reduced by the use of the auxiliary slide. A tool of this design need never become obsolete, owing to the fact that it can be easily equipped for application to a large variety of work.

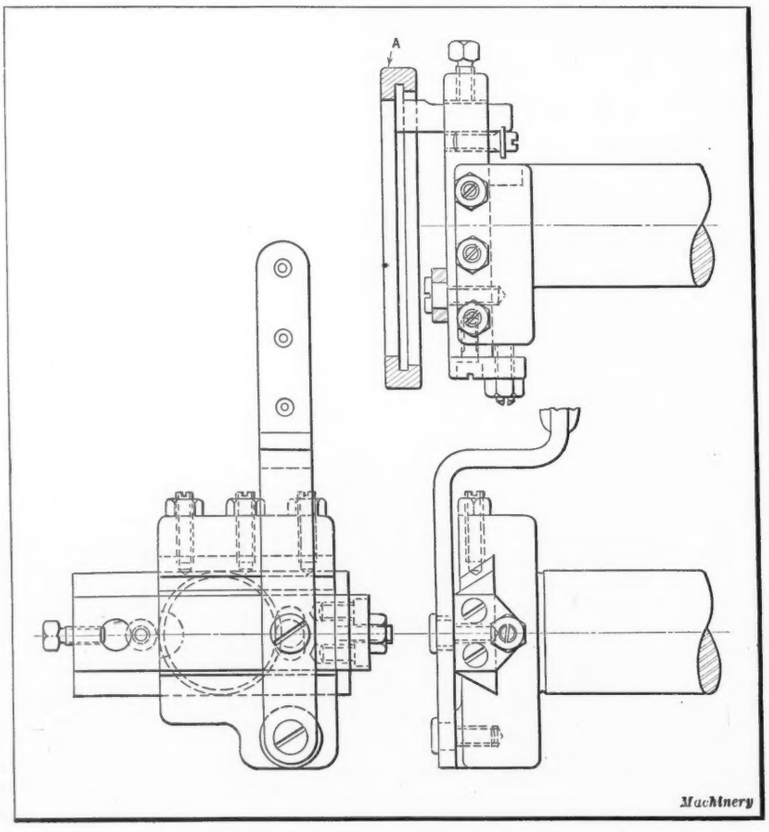


Fig. 2. Lever-operated Cross-slide set up for Recessing Operation

The tool shown in Fig. 2 is similar in design to that shown in Fig. 1. It was originally intended for performing a recessing operation on the part shown at *A*, but it could also be used without change for a variety of boring, facing, or forming operations by providing the necessary style of cutter. This type of tool provides a convenient means of finish-forming when the cross-slide toolposts are used for rough-forming and cutting off. Circular forming cutters for this kind of work should be made with stems to suit the holder. If the holder is intended to be used with a large variety of cutters, it should have a larger hole than otherwise and be provided with a set of bushings to correspond with the cutters.

A somewhat different style of holder is illustrated in Fig. 3, which was designed to accommodate three cutters, as shown. The question of using the regular feed of the hand screw machine or that of the auxiliary slide depends largely upon the class of work to be done, and whether a high production rate or extreme accuracy is more desirable. The use of auxiliary slides of the types described would greatly increase the accuracy obtainable on hand screw machines having worn cross-slides and turret-slides or turret tool-holes that have become battered and out of alignment.

In such cases it is possible to obtain quite accurate results if the work is chucked and has a hole in the center (as is usually the case) by aligning the turret tool with the spindle by means of a pilot on the tool and a bushing in the spindle. The slide on the tool would then take the place of the worn cross-slide for the finishing operation, with results equivalent to those obtained with a new machine. In Fig. 4 is shown an auxiliary tool-slide adapted for use on a bench lathe, bench mill, floor lathe, or hand screw machine. The work shown at *A* was more accurately machined by the use of the special tool-slide in this particular case than it could have been by using the regular cross-slide and a forming tool. This special tool also made it possible to increase production more than 100 per cent.

Waynesboro, Pa. D. A. NEVIN

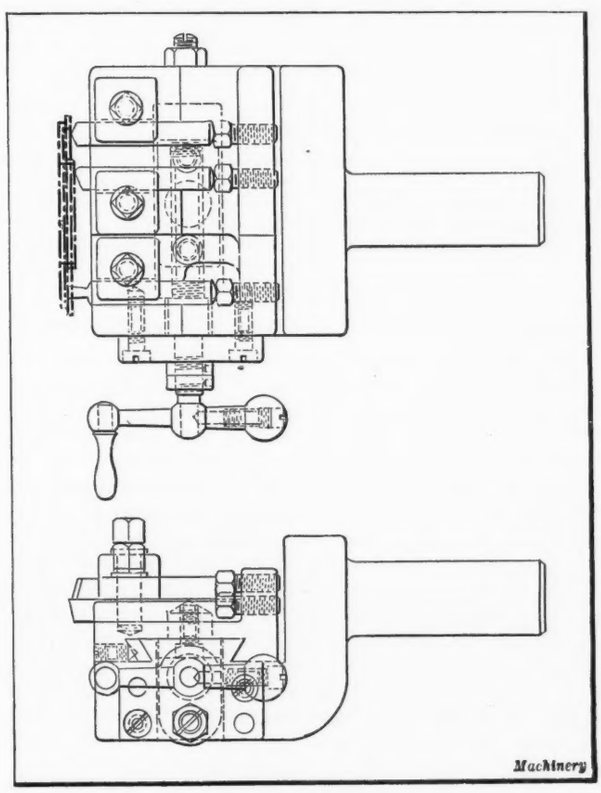


Fig. 3. Screw-fed Auxiliary Cross-slide for Turret Lathe

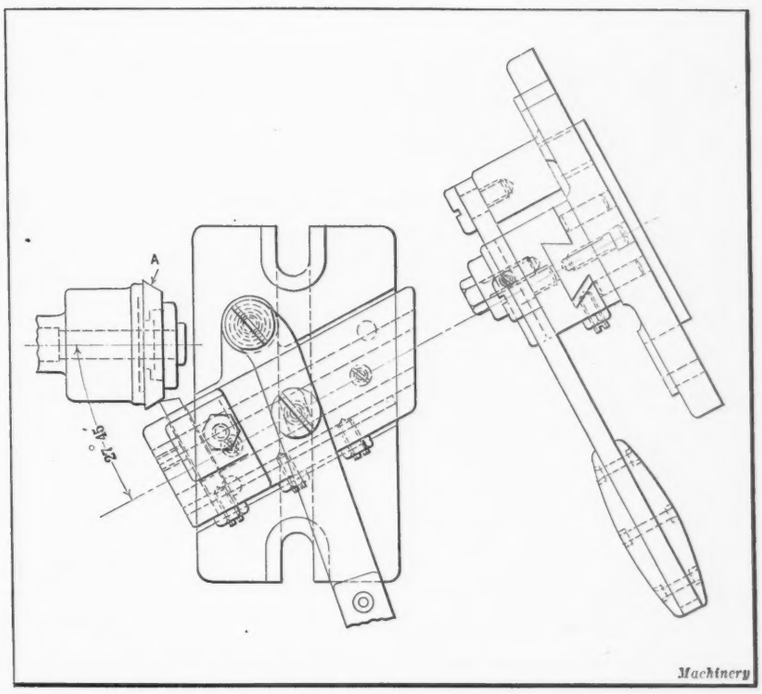


Fig. 4. Auxiliary Cross-slide for Bench Lathes, Bench Mills, etc.

* * *

HENDEY MACHINE COMPANY 1870-1920

An anniversary volume entitled "Hendey 1870-1920" has been published by the Hendey Machine Co., Torrington, Conn., in which is recorded the history of the company from the time of its foundation in 1870 until the end of the first half century of its existence. This book contains an interesting account of the founder, Henry J. Hendey, of this well-known machine tool building enterprise, of whom it says that "confronted by adverse conditions, hampered by lack of money, but with a splendid faith in what the future held, his many fine qualities and sheer strength of character asserted themselves. An unshaken courage, a steadfast determination, decision; these were his outstanding characteristics."

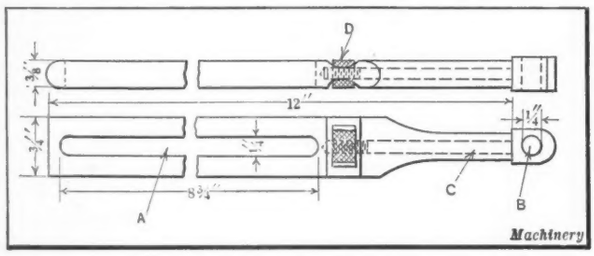
In 1870, Henry J. Hendey, a toolmaker of Torrington, Conn., and his younger brother Arthur Hendey, then a pattern-maker in New Haven, associated themselves in the launching of a new enterprise with a very humble beginning. In referring to the starting of the business, the review states that "in the present period of business inactivity, there is a homely lesson in the courage and confidence of the founder of this enterprise, who, due to business depression, was at the time unemployed, but who did not hesitate to face forward, backed only by mentality and muscle and that invariable and constant asset, an unfaltering faith in America."

The motive power of the first shop was a three-horsepower rotary engine made by Henry Hendey at night after leaving his daily task. This engine has been preserved and is still to be seen on a table in the engine room of the present Hendey plant in Torrington. The gradual growth of the business from its small beginning to its present proportions is well illustrated by many interesting photographs showing the earlier shops and the present plant. The book also shows the development of the types of machines associated with the name Hendey, from the simple designs of 1870 to the high-production shapers, milling machines, and lathes of 1922. It is being distributed to the friends and customers of the company.

SHOP AND DRAFTING-ROOM KINKS

UNIVERSAL INDICATOR HOLDER

The device shown herewith was made by the writer for the purpose of holding an indicator in any desired position. The slot *A* permits the holder to be attached to a machine or fixture by means of a ¼-inch bolt or cap-screw. A ¼-inch hole *B* in the threaded member *C* provides a means of holding the indicator itself. Part *C* is a good fit in the shank of the holder, and is clamped in position by means of a knurled nut *D*. From the illustration it will be noted that slot *A* provides a means of adjusting the position of the indicator either outward or inward for a distance of approximately 8 inches, and that part *C* to which the indicator is directly attached can be revolved about its axis and locked in any desired position.

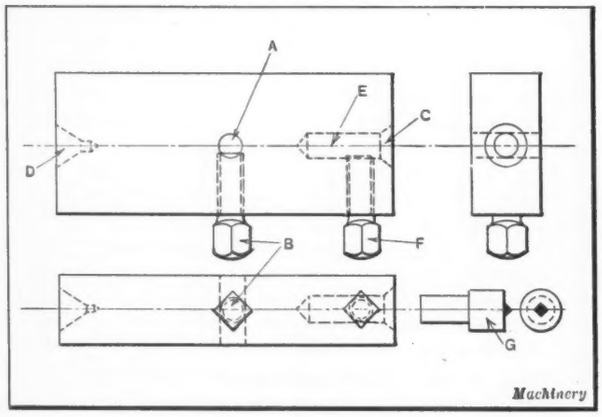


Adjustable Holder for Indicator

Rochester, N. Y. PHILIP A. HALL

HOLDER FOR TRUING DIAMOND

A convenient diamond-holder for tool-room work is shown in the accompanying illustration. It may be made from a piece of ½- by ¾-inch machine steel about 3½ inches long. It is finished all over and can be held on a magnetic chuck for truing surface-grinder wheels. For this work the flat side of the holder is placed on the magnetic chuck with the diamond held in hole *A*, where it is locked in place by set-screw *B*. It is understood, of course, that the diamond itself is mounted in a short round holder *G*. For truing a wheel on an electric toolpost grinder, the block is held by means of the centers *C* and *D*, the diamond being held in the same position as when used on a surface grinder. The machine centers should be screwed up tight to prevent the block from turning; excessive pressure, however, is not necessary if large centers are made in the block at *C* and *D*. The diamond-holder may also be held in a vise with the diamond clamped in hole *E* which is on the same center line as the countersunk center *C*. In this position, the diamond is locked in place by screw *F*.

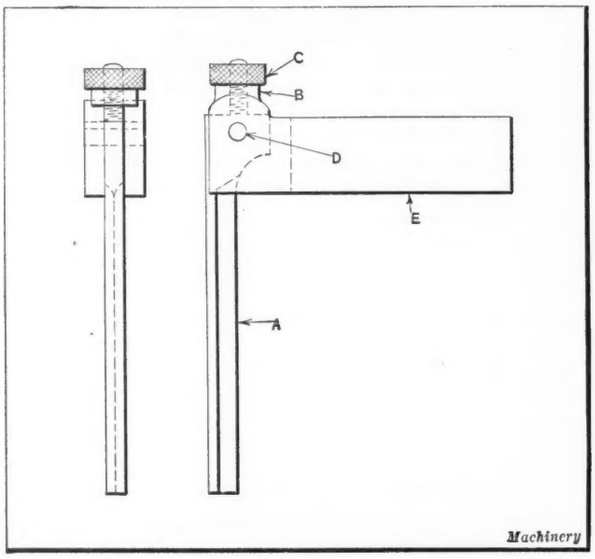


Holder for Grinding-wheel Truing Diamond

Ilion, N. Y. D. R. GALLAGHER

DIEMAKER'S SQUARE

The square shown in the accompanying illustration is of unusual design. It has the distinct advantage of being readily set to any angle within the narrow limits usually called for in diemaking. The body *E* is slotted at the front end to receive the blade *A*, and the latter is threaded at the top for nut *C*. Washer *B* is fitted to the radial part of body *E* and is a sliding fit on the screw. When nut *C* is tightened the blade will retain its exact setting, as washer *B* does not turn with the nut. The blade *A* is machined to a knife-edge on one side and swivels on a pin *D*. It can be assembled with the knife-edge down if desired.



Diemaker's Square

Rosemount, Montreal, Canada HARRY MOORE

* * *

WORK OF THE DEPARTMENT OF COMMERCE

The Bureau of Foreign and Domestic Commerce, the Bureau of Census, and the Bureau of Standards are at present the three chief points of contact between the Government and the commerce and industry of the country. These three bureaus receive annually about 300,000 inquiries. In a single day the Bureau of Foreign and Domestic Commerce received 514 inquiries from commercial concerns all over the country having to do with the promotion of foreign trade. The greatest difficulty under which the department labors is that the salary scale of the men and women employed in this important work dates back to 1914, and hence in many cases their compensation is about one-half that obtained for similar work in the general commercial field. The department is essentially in competition with business houses in finding men, and the economic pressure exerted on those employed by the department from the outside is constant and must be recognized. In the Bureau of Standards alone the turnover during the last five or six years has been about 50 per cent.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

LEATHER WASHERS FOR CLEANING SHAFTING

R. F. B.—How are leather washers applied to lineshafting to keep the shafting clean between the pulleys?

A.—The leather washers which are sometimes used for this purpose simply have holes that are considerably larger than the shaft, so that the washer may easily be turned or twisted to an inclined position relative to the shaft. As the shafting revolves, the washer travels from one pulley to another, and when it comes into contact with the hub of a pulley its angular position is changed, so that it begins to travel in the opposite direction. The backward and forward movement is continued automatically, and as the result the shaft is kept clean and bright.

ROLLER BEARING TANGENCY PROBLEM

L. W. C.—In making tapered roller bearing cones, it sometimes happens that the cone is required to be ground accurately to a given radius r, Fig. 1. AB represents the back face of the finished cone, CD the back face of the cone before grinding, EF the finished bore, and GH the bore before finishing. In cases of this kind it is obviously important that the proper allowance be made for finish-grinding. The destructive effect of a sharp point or edge of steel on the face of the grinding wheel makes it desirable to so proportion the cone that as little stock as possible will need to be removed at the point where the back face joins radius r. The problem of determining radius R occurs when it is planned to make the radius of the unfinished forging and the finished radius tangent to each other in order to eliminate as far as possible the use of the wheel where the destructive effect is greatest. The problem, therefore, consists in determining the radius R, of a circle which is tangent to a given smaller circle, and to two lines at right angles to each other at given unequal distances from tangents to the smaller circle, as indicated in Fig. 2. In the illustration, the dimensions a, b, and r are known. Please show how to find R.

A.—In solving this problem, we may start out with three equations, assuming three unknown quantities R, y, and z, Fig. 2. From these three equations we obtain by substitution the final equation in which R is the only unknown quantity. Note that $x = \sqrt{y^2 + z^2}$.

We then have the three equations:

$$R = x + r = \sqrt{y^2 + z^2} + r \quad (1)$$
$$R = y + r + a \quad (2)$$
$$R = z + r + b \quad (3)$$

Transposing,

$$z = R - r - b$$

Then, from Equation (1),

$$R = \sqrt{y^2 + (R - r - b)^2} + r$$

Transposing terms in Equation (2) we have,

$$y = R - r - a$$

Therefore

$$R = \sqrt{(R - r - a)^2 + (R - r - b)^2} + r$$

It is, of course, possible to solve this equation for R by transposing r to the left-hand side of the equation and then squaring both sides, which will result in a quadratic equation. In a problem of this type, however, the trial method will be equally rapid—that is, a trial value may be substituted for R that is as nearly exact as it is possible to determine by measuring a scale drawing. The substituted value is then slightly adjusted until it satisfies the equation.

CALCULATING DIAMETER OF ROLL FOR ROLLER CLUTCH

W. A. Z.—In the accompanying diagram are shown the conditions encountered in the design of a roller clutch. From the dimensions given, please explain the method of finding the diameter of the roll.

ANSWERED BY LEWIS D. CASTOR

A.—Referring to the diagram, it will be evident that

$$OK = \sqrt{1.25^2 + 0.25^2} = 1.2747$$

$$\text{Sin } OKA = \frac{0.25}{1.2747} = 0.19612$$

Hence

$$OKA = 11 \text{ degrees } 19 \text{ minutes}$$

By construction, angle $AKH = 60$ degrees; therefore

$$OKH = 60 \text{ deg.} + 11 \text{ deg. } 19 \text{ min.} = 71 \text{ deg. } 19 \text{ min.}$$

and

$$HK = r \times \sec 30 \text{ degrees} = r \times 1.1547$$

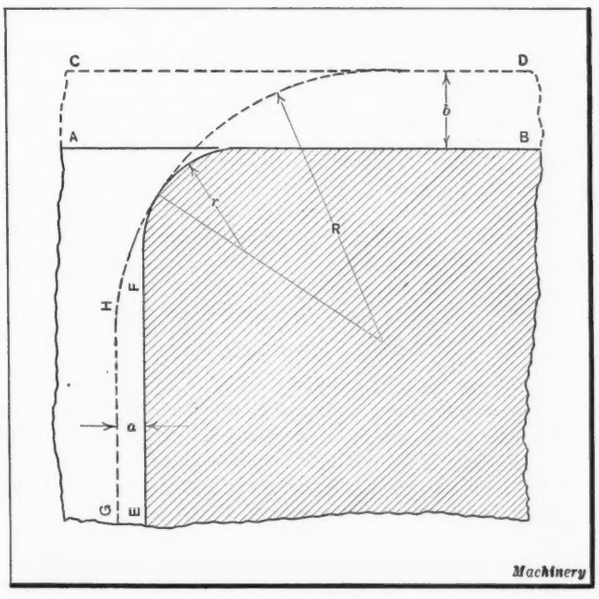


Fig. 1. Section of Roller Bearing Cone illustrating Tangency Problem

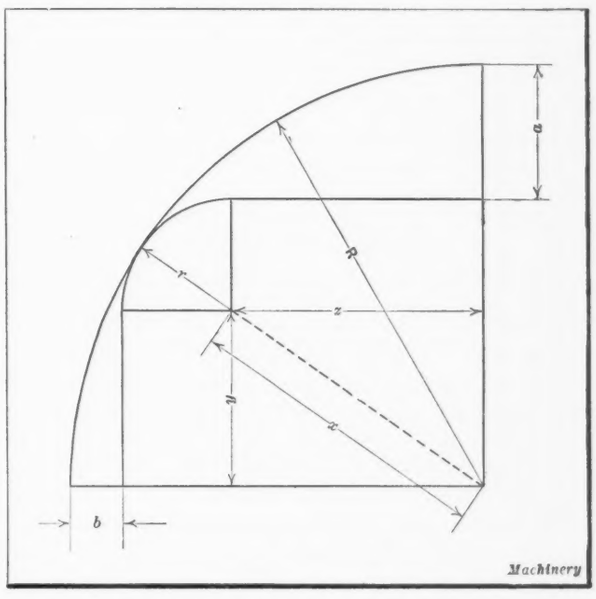


Fig. 2. Diagram used in the Solution of the Tangency Problem

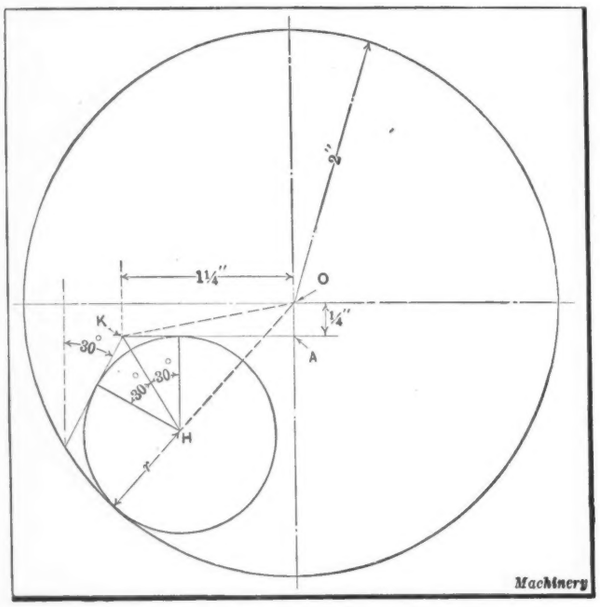


Diagram for finding Diameter of Roll for Roller Clutch

Also

$$OH = 2 - r$$

According to the equation given in MACHINERY'S HANDBOOK, page 152, for solving an obtuse-angled triangle, when two sides and the angle between them are known, we have:

$$OH \text{ or } 2 - r = \sqrt{HK^2 + OK^2 - 2\,(HK \times OK \times \cos OKH)}$$

Substituting the numerical values of the known quantities,

$$2 - r = \sqrt{(1.1547r)^2 + 1.2747^2 - 2\,(1.1547r \times 1.2747 \times 0.32034)}$$

$$2 - r = \sqrt{1.3333r^2 + 1.6248 - 2\,(1.1547r \times 0.40833)}$$

$$= \sqrt{1.3333r^2 - 0.9430r + 1.6248}$$

Squaring the left-hand member, we have,

$$4 - 4r + r^2 = 1.333r^2 - 0.943r + 1.625$$

Transposing and uniting terms

$$0.333r^2 + 3.057r = 2.375$$

or

$$r^2 + 9.18r = 7.1321$$

Solving this quadratic equation according to the formula given in MACHINERY'S HANDBOOK, on page 100,

$$r = -\frac{9.18}{2} \pm \sqrt{\frac{9.18^2}{4} + 7.1321}$$

$$r = -4.59 \pm 5.3104$$

$$r = 0.7204 \text{ inch}$$

Hence the diameter of the roll is equal to $2r$ or 1.4408 inches. It will be noted that in the foregoing solution only such formulas as are to be found in MACHINERY'S HANDBOOK are employed.

REMOVING ONE-HALF THE VOLUME OF A SPHERE

F. D. K.—Please give a general method of determining the diameter of the hole that must be drilled through the center of a 3-inch sphere to remove one-half the contents.

ANSWERED BY W. W. JOHNSON, CLEVELAND, OHIO

From the diagram it will be seen that the material to be removed by drilling consists of two equal spherical segments and a cylinder.

Let R = the radius of the sphere, and
$2h$ = the altitude of the cylinder.

Then

$R - h$ = the altitude of the spherical segment

and

$\sqrt{R^2 - h^2}$ = the radius of the base of the segment and the radius of the cylinder.

The volume of the two spherical segments in terms of R and h is:

$$2[1/2\ \pi(R - h)\ (R^2 - h^2) + 1/6\ \pi(R - h)^3]$$

and the volume of the cylinder $= 2\pi h(R^2 - h^2)$

To remove $\frac{1}{n}$ of the sphere we have 2 times the volume of one segment plus the volume of the cylinder $= \frac{1}{n}$ the volume of the sphere.

Therefore,

$$\pi(R - h)\ (R^2 - h^2) + \frac{1}{3}\pi(R - h)^3 + 2\pi h(R^2 - h^2) = \frac{1}{n}\left(\frac{4}{3}\pi R^3\right)$$

Expanding and combining terms,

$$\frac{4}{3}\pi(R^3 - h^3) = \frac{1}{n}\left(\frac{4}{3}\pi R^3\right)$$

Removing the factor $\frac{4}{3}\pi$,

$$R^3 - h^3 = \frac{1}{n}R^3 \qquad (1)$$

Again, referring to the diagram, $h = R \cos \phi$. Substituting this value for h in Equation (1), and removing the factor R^3,

$$\text{Cos}^3\ \phi = 1 - \frac{1}{n} = \frac{n-1}{n}$$

and

$$\text{Cos}\ \phi = \sqrt[3]{\frac{n-1}{n}}$$

To remove one-half the volume of the sphere, let $n = 2$. Then

$$\text{Cos}\ \phi = \frac{1}{\sqrt[3]{2}},$$

and

$$\phi = 37 \text{ degrees } 28 \text{ minutes } 2 \text{ seconds}$$

Let D = diameter of sphere, and
d = diameter of hole.

Then,

$$d = D \sin \phi$$

For a 3-inch sphere this gives $d = 1.825$ inches.

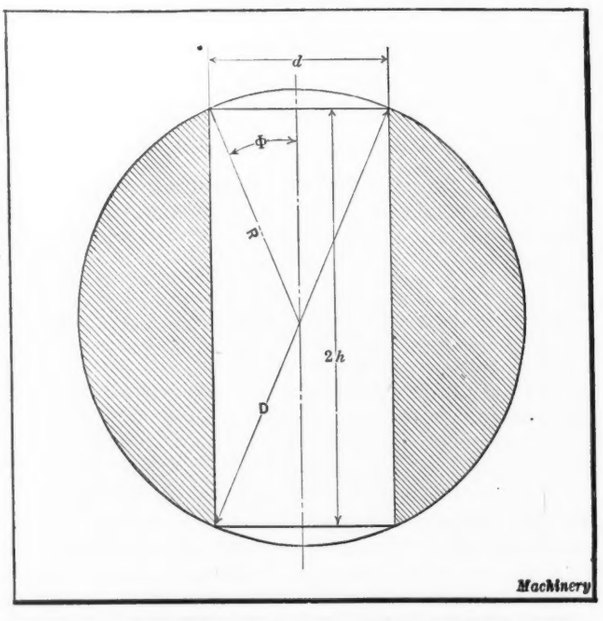


Diagram used in deriving Formula for removing One-half the Volume of a Sphere by drilling a Hole through its Center

The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, April 14

AT the time of writing, the engineering dispute involving a lock-out of 250,000 men dominates all other conditions in the metal-working industries. The dispute hinges on the question of managerial rights, working conditions, and over-time. There is no evidence that a majority of the Amalgamated Engineering Union seriously challenges any fundamental rights of management, and it is expected in many quarters that the real bone of contention will ultimately be found to be a case of wage reduction.

That trade has dropped to a low ebb, due to the effect of the engineering dispute, cannot be denied, but this condition, it is thought, is only momentary. Indications of better conditions are too pronounced to admit of denial.

The Machine Tool Industry

Most of the firms engaged in the machine tool industry are members of the Engineers' Employers Federation, so that all the workers are locked out except apprentices. Prior to the lock-out the machine tool industry showed flickers of improvement, more particularly in connection with foreign business, which indicated an early revival.

A welcome piece of news was the statement made at the recent annual meeting of the Machine Tool Trades Association that 90 per cent of the government stock of surplus machine tools had been disposed of, and that only about 2500 machines remained to be sold. Altogether the Disposal Board has sold over 60,000 machines. Unfortunately government disposal does not represent the end of the matter, because it does not follow that the machines sold are actually in use; in fact, a considerable proportion of the machines are in the hands of dealers and will be certain to make their reappearance on the market as the demand increases.

A number of inquiries for machine tools has been received from abroad, but buyers are insistent on getting the lowest prices possible. As an indication of this, it might be mentioned that in some cases orders have been offered at 25 per cent less than the price quoted. This, of course, does not represent the average buyer's idea, but applies more to cases where machines can be used to advantage but are not urgently needed. Wage reductions in prospect always have two effects—either the buyer decides to wait until he can get the full benefit of reduced manufacturing costs, or if he does place an order, he expects the manufacturer to charge on the basis of the new wage rates.

One of the paramount troubles in the trade is the accumulation of stocks that can be replaced for less than the original cost of manufacture and that will still further depreciate in value as greater reductions are made in wages. Losses appear to be inevitable in the case of machines manufactured under the artificial conditions of a year ago. Activity is displayed in the small tool line, but orders are mostly for small quantities and quick delivery.

The Automobile Industry

In the automobile industry it is particularly unfortunate that the labor dispute should come along just at this time. During the last few weeks many promising inquiries from abroad have been reaching the manufacturers, and with the home season developing satisfactorily, factories have been actively preparing for increased output. Most firms are members of the Engineers' Employers Federation, and they have been forced to get along without toolmakers and fitters, who probably represent about 20 to 25 per cent of the total force. A number of machine operators and assemblers remain at work, but they cannot maintain production much longer alone.

The scarcity of stocks will bring deliveries to a standstill in many shops unless terms are speedily agreed upon. In certain departments there has been a considerable accumulation of finished parts for the completion of orders already started, but if production is interrupted in other allied branches these stocks will not help. Normally, manufacturers have plenty of materials and can go ahead safely in anticipation of the spring season, but there are various considerations which have deterred them from doing so this year. For instance, there is the lack of working capital and the restrictions on credit. Then there is the desire to get the utmost advantage from a falling market for raw materials. Most firms have, in fact, based their prices for this year's models on the assumption that materials would have reached a lower level. The light car makers are the busiest, but some of the commercial truck makers are working overtime.

Railway and Locomotive Engineering

Locomotive builders report conditions improving, especially inquiry from abroad, and will doubtless find an outlet for their product as soon as the present labor troubles are over. The Rumanian state railways, it is understood, contemplate placing a large order in which Glasgow manufacturers are expected to participate. Structural engineers have better prospects, perhaps, than any other branch, chiefly owing to railway developments in the Colonies and abroad. An important contract, involving a sum of £350,000, has been received by William Arrol & Co., Ltd., the well-known Glasgow engineers and bridge-builders. This is for the erection of work-shops for the Mexican State Railways at Enugo, and is the initial part of a big development scheme which includes the erection of a bridge over the river Benue.

The Iron and Steel Field

For the most part iron and steel users are buying only for immediate requirements, and in view of the uncertainty of the labor situation it is but natural that they should restrict their purchases at the present time. Even so, values remain steady. No inclination to delay deliveries of pig iron under existing contracts is noticeable, and some pressing inquiries have been received from Continental countries, including one of 1400 tons from Germany. Italy and Belgium are also in the market.

In the gray iron and malleable foundries, there is much more activity. One firm in Birmingham recently began a night shift and is making extensions to its plant that will double its output. This firm states that although the orders for castings are principally for the automobile industry, a good general trade has developed in the last few weeks.

The small concessions made by railway companies in the transit rates of fuel to steel works and blast furnaces have proved of little value, and the export trade is hampered by comparatively high freight rates.

Shipbuilding

The shipbuilding industry, at the time of writing, is at a standstill owing to the cooperation with the engineers' union, but quite apart from that disturbing feature, it must be some time before orders will mature from this quarter. The machine tools in the shipyard engineering shops which, under normal conditions of night and day shifts last about two years, have not been worked under these conditions since the armistice, and consequently are still in good condition.

RECIPROCATING MOTION MECHANISM

By DAVID ERSSON

The reciprocating motion mechanism which is described in this article is one important unit in the construction of a washing machine. The principal driving members of the mechanism consist of the commonly employed gear and double pinions, the latter being located diametrically opposite each other. The reversing parts are of simple construction and are designed to eliminate wear and friction as far as possible. They have been found to work faultlessly and are positive in their action. In Figs. 1, 2, and 3 the same reference letters are used to denote the same parts.

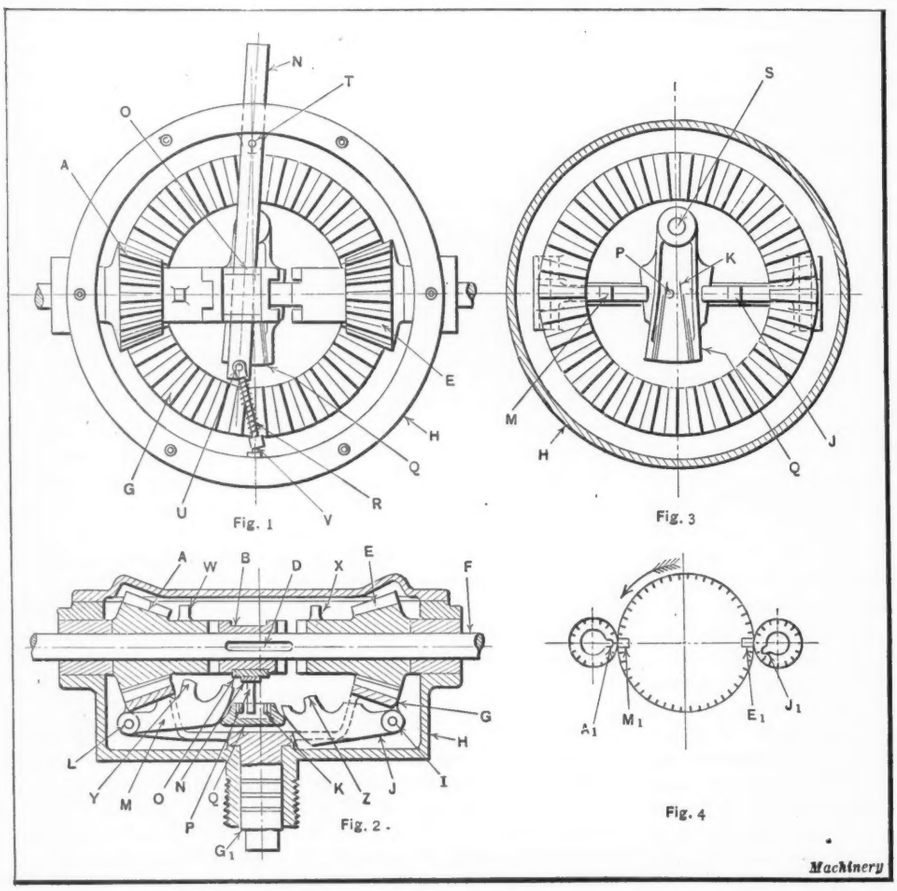
The cast-iron housing *H* carries the vertical shaft G_1, which connects the main gear *G* with the drum on the washing machine. The two pinions *A* and *E* run on the horizontal shaft *F* which is connected with the motor or power source. This shaft is provided with a key-slot and key *D* upon which the double-ended clutch jaw *B* slides. The center of this clutch jaw is recessed to receive a semicircular bushing *O*. This bushing has a square section on its outer side which is in contact with the starting and stopping lever *N*. The bushing *O* is provided with flanges on both sides which keep lever *N* in its proper position.

Another lever *Q* swivels on a stud *S* driven into gear *G*. Movement is imparted from lever *N* to lever *Q* by a pin *P* which is driven into lever *N*. This pin extends down into a recess in lever *Q* and works against two shock-absorbing springs *K*, one spring being located on each side of the recess. Gear *G* carries, besides stud *S* and reversing lever *Q*, the two cams *J* and *M* located in slots which extend below the gear and toward the center. These cams are arranged diametrically opposite each other and are pivoted on their respective studs *I* and *L*.

The form of the cams is best seen by reference to Fig. 2. On the upper side of the cams are located lugs *Y* and *Z* which at intervals come in contact with lugs *W* and *X*, the latter being cast on the extensions of pinions *A* and *E*. The purpose of the cams is to push lever *Q* over the center, one cam coming into action when the main gear is revolving to the right and the other when it is revolving to the left. Thus when cam *M* is in the position shown with lever *Q* over to the left of the center, lug *Y* comes in line with lug *W* on pinion *A* at a certain moment. When this happens lug *W* pushes the cam down and this, in turn, forces lever *Q* over the center to a similar position on the right, carrying with it the other movable parts—pin *P*, lever *N*, bushing *O*, and clutch jaw *B*. The latter member is now disengaged from pinion *A* and engaged with pinion *E*, thus imparting the reciprocating or reversing motion to gear *G*.

When lever *Q* moves over to the right it also pushes cam *J* up into a new position, ready to act similarly to the other cam. To obtain a good working action, there must be a certain ratio between the gear and the mating pinions, and this ratio must be based on the number of revolutions which the washing machine barrel is required to make before reversing. In this case eight revolutions are chosen for half a period, or double that (sixteen revolutions) for one whole period. To obtain this, the ratio must be 8 to 23. The number of teeth in this case is 16 for the pinions and 46 for the gear. Another thing to be taken into consideration is the location of the lugs on the pinions. Fig. 4 shows a diagrammatical lay-out of the relative positions of these lugs in regard to each other and also to the cams. Assume that the barrel of the washing machine has completed one period of sixteen revolutions and is ready for the next period, and that the gear will now revolve in the direction indicated by the arrow for the next eight revolutions. After completing the eight revolutions, the direction of rotation is reversed by means of lug J_1, which comes in contact with cam E_1. To obtain this action, the gear and pinions must be so assembled that lug J_1 lacks just two tooth spaces of making contact with cam E_1, when lug A_1 is in contact with cam M_1, as illustrated.

When the required eight revolutions are completed, lug A_1 again comes in contact with cam M_1 and the motion is reversed again for the next eight revolutions. A coil spring *R*, Fig. 1, holds lever *N* in the required position on each side of the center. This spring is seated at point *V* on the housing, and is guided on the lever by means of a pin *U*. Lever *N* is mounted on a pin *T* located diametrically opposite point *V* on the housing. The lever is extended outside the casing so that the operator can get a good grip on it for starting and stopping the mechanism.



Figs. 1 to 3. Reversing Mechanism used on Washing Machine. Fig. 4. Diagrammatical Lay-out showing Relative Positions of Reversing Lugs

* * *

The installation of sixty-seven double-frame steam drop-hammers at the Highland Park plant of the Ford Motor Co., Detroit, now in process, is an important step by the Ford organization in its plan to do practically all of its own drop-forging work. The new hammers range in size from 800 to 5000 pounds' capacity and are being placed in operation immediately upon being set up.

STRIPPERS FOR DRAWING DIES

By N. T. THURSTON

The success of a drawing die or push-through die depends largely upon the efficiency of the stripper employed to strip the stock from the punch on the upward stroke of the press ram. Even with a properly designed stripper there is likely to be some spoilage, particularly when drawing light gage metal. This spoilage is increased, of course, when the stripper is not the correct type for the work. Each of the three styles of strippers described in the following has its distinct features, and it is the purpose of this article to make clear the class of work for which each has been found best adapted.

Stripper for Small Work

The die shown in Fig. 1 is equipped with a type of stripper which has proved satisfactory for small work. This stripper, however, will seldom be found suitable for shells over 1 inch in diameter. A shell of 22-gage brass stock, ½ inch in diameter and 2 inches long is representative of the class of work for which this type should be used. The stripper consists of a split ring of tool steel composed of four parts or segments. As shown in the illustration, the segments are grooved to receive a circular wire spring *A* which holds them in place. As the shell is pushed through the die and enters the stripper, the segments are forced back allowing the shell to pass through.

On the return stroke of the punch the segments grip the punch above the shell and thus serve to strip the shell from the punch. This stripper is the least positive of the three described in this article, and its success depends upon using it with shells of small diameter having thin walls. The stripper is held flat and in place by the tool steel forming plate *B*. This plate, in turn, is kept in position by the three clamps fastened to the top of the die, one of which is shown at *C*. By merely removing the clamps, the forming plate and the stripper are left free so that they can be lifted from the die.

Stripper for Thick-walled Shells

The die shown in Fig. 2 is equipped with spring-actuated strippers, and has been found to be best suited for use in dies employed for drawing thick-walled shells varying from 1½ to 5 inches in diameter that are less than 6 inches in length. This die is mounted on a machine steel base while the forming parts are of tool steel, hardened and ground. The strippers *A* are also of tool steel, hardened and ground, and are kept in constant contact with the shell by the compression springs *B* which force them outward into the die opening. These strippers are provided with a shoulder so that they can extend into the die opening only a certain distance, and they are made a good sliding fit in the slots in ring *C*.

As these strippers have only a small bearing surface on the shell, it is necessary to make them rather sharp on the edges which come in contact with the work. As will be

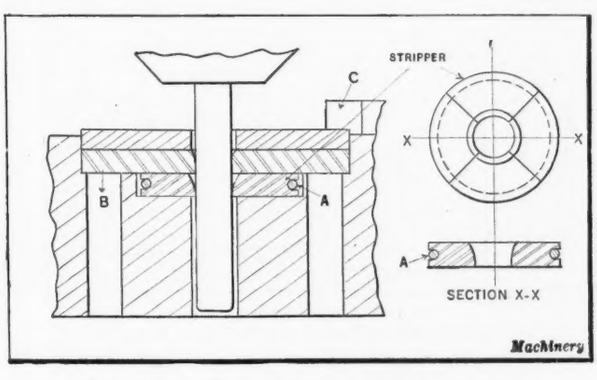


Fig. 1. Drawing Die equipped with Segment Type Stripper

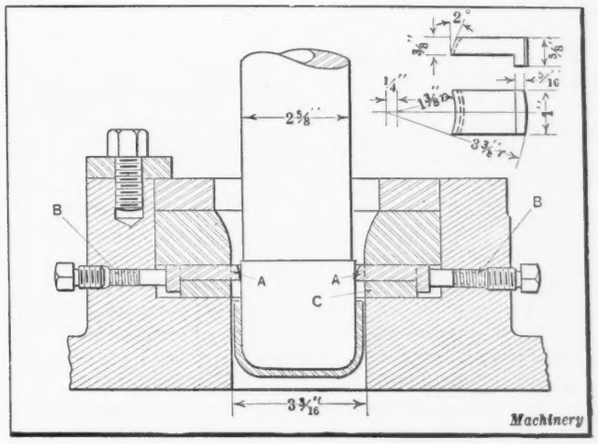


Fig. 2. Die equipped with Two Spring-actuated Strippers

noted by referring to the view in the upper right-hand corner of Fig. 2, the end of the stripper which bears on the work is not only rounded, but also beveled at an angle of 2 degrees. For this reason the stripping action is severe, and shells having thin walls are found to tear and wrinkle badly when this type of stripper is used. This type, however, is the most positive of the three types described in this article. It has proved most successful when used on shells having a wall thickness of not less than 20 gage. A shallow 8-gage steel shell, for instance, is well handled by this stripper, whereas a stripper of the type shown in Fig. 1 would be entirely unsuitable. The rate of production on work of the type shown in Fig. 2 can be very high, as a good operator, protected by safety devices, can keep the press running continuously, 5000 pieces in a ten-hour day being the average production.

Stripper for Large-diameter Thin-walled Shells

The die shown in Fig. 3 is equipped with a stripper constructed on an entirely different principle from that of the strippers previously described. In the types described, spring pressure is applied at right angles to the part of the shell being pushed through the die. In the type shown in Fig. 3, however, spring *A* applies pressure in a direction parallel to the path of the shell, and the gripping action of the jaws *B* is similar to that of a collet. This die is held in a cast-iron base, the forming ring being tool steel, hardened and ground, as are also the gripping jaws. The plate *C* held to the bottom of the die by four ½-inch screws (not shown) is machine steel and holds the six action-pin springs in place.

As the shell passes through the forming ring, it strikes the jaws of the collet and forces them down and outward. The ¼-inch clearance at *D* between the bottom of the jaws and the top of the machine-steel ring below them permits this downward movement. At the end of the downward stroke the top of the shell is still in contact with the base of the jaws, which, actuated by the constant spring pressure forcing them upward, grip the shell and hold it fast while the punch continues upward and thus strips the shell off so that it drops through the die at the next stroke.

The action-pins *F* are made from 1-inch cold-rolled stock machined to ½ inch at both ends. A clearance of ⅛ inch is provided in the holes in which the pins enter the jaws. Without this clearance the jaws would not be able to expand or contract. The pins extending into the base of the jaws for about ½ inch serve to keep the jaws from moving in a circular direction. The compression springs used on the pins have an inside diameter of ⅝ inch and a length of about 2½ inches. The gripping power of the stripper is adjusted by the machine-steel ring *E* which lies on the top of the jaws. By grinding off the under side of this ring against which the jaws are forced by the springs, a greater upward and inward movement of the jaws is permitted.

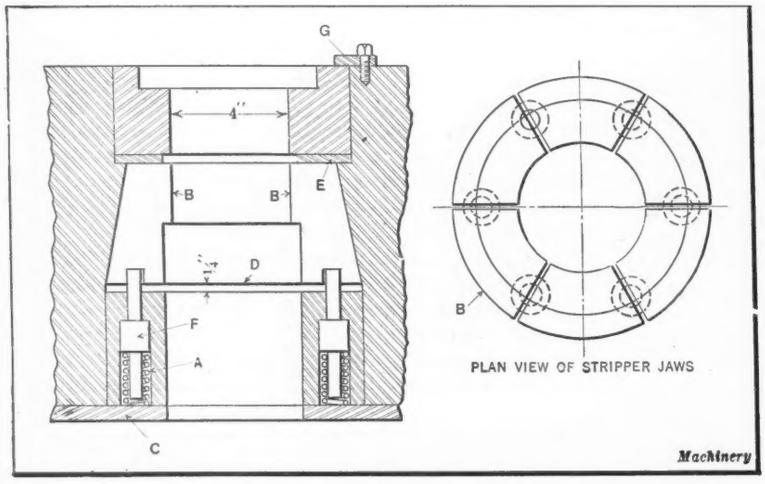


Fig. 3. Push-through Die fitted with Stripper adapted for Long Thin-shelled Work

This of course causes the shell to be more tightly gripped. To provide for an equal pressure on the jaw sections, the spring-actuated pins are placed under the separations in the jaws so that each pin bears on two sections of the stripper at the same time. The forming ring in the top of the die is left loose and can be lifted out of the die at any time by removing the three cleats *G* at the top.

This type of stripper was found to be the best for stripping shells about 4½ inches in diameter and about 12 inches long, which were being pushed through the die on a rack-and-pinion press. Inspection of the shells pressed through the die on which this stripper was employed, showed that less than 2 per cent failed to pass because of defects resulting from the stripping operation, whereas about 15 per cent were spoiled when a stripper of the type shown in Fig. 2 was employed. The stripper shown in Fig. 3 is best suited for stripping shells of rather large diameter having comparatively thin walls. The reason that it is useful on such work is that it has a large bearing surface which comes in contact with the work during the stripping operation.

* * *

REPAIRING CRANKSHAFT OF PUMP

By JAMES ELLIS

The writer recently had occasion to assist in repairing a hydraulic pump that had given considerable trouble. The pump was of the four-cylinder type having a crankshaft of the design shown at *A*. The break occurred at the point *B*, as indicated by the broken line. Several crankshafts had previously broken at this point and several sets of gears had also been worn out in an incredibly short time.

The difficulties encountered in replacing a pump crankshaft of this type will be readily understood by those experienced in the design of this kind of pump. The method of overcoming these difficulties in making the repair should therefore be of interest to designers as well as to those handling repair work. The chief difficulty in replacing the gears, pinions, pinion-shaft, or crankshaft of a pump of this type is in obtaining accurate alignment of the pinions *F* with respect to each other, and also with respect to their mating gears *G* which must also be properly aligned on the crankshaft.

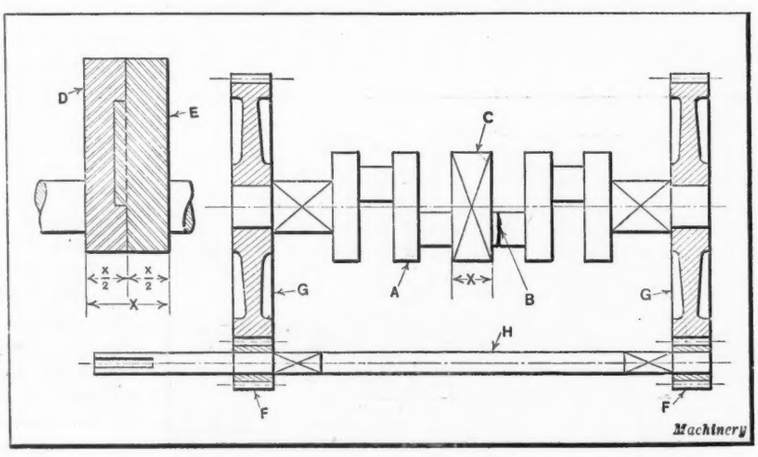
If any of these members are out of alignment, the torque produced in shaft *H* and in the crankshaft will cause unequal loads to be imposed on the gears, which will result in unequal wear on the gear teeth. As the wear increases, the difference in the load carried by each gear also increases until some one of the stressed members is broken.

In making the repair, the halves of two broken crankshafts were used. The bearing *C* of one broken crankshaft was machined as shown at *D* in the enlarged sectional view at the left, while the bearing of the other half was machined as shown at *E* to fit the recess in *D*. This allowed the load to be evenly distributed on the gears as was originally intended; that is, the gear at the right-hand end of the crankshaft and its mating pinion would carry one-half the load, while the gear and pinion at the other end of the shaft would carry the other half of the load. The full width of the original bearing surface at *C* was retained, and the shoulder (shown in the enlarged view at the left) allowed the thrust from the cylinders to be transmitted from one half of the bearing *C* to the other half, and at the same time it did not allow any of the turning force to be transmitted from one end of the crankshaft to the other.

At the time that this repair was made it was regarded as more or less of a makeshift, but after noting the satisfactory manner in which the pump operated, the writer has been led to believe that this construction would not be out of place in a new machine, provided that a large sized bearing is used at the center of the crankshaft. This construction would eliminate much of the tedious work of laying out keyways and the cost of production would be lowered. The pump repaired in the manner described has been in operation twenty-four hours a day for several months. A new shaft previously installed broke before it had been in operation for that length of time. The drive pinions are also resisting wear much better than they did when the one-piece crankshaft was used. The extra cost of making the shaft in two sections would probably be more than compensated for when building new machines, by the time saved in assembling.

* * *

Farmers of New York State, according to the *Review of Industry*, have taken a decided stand in favor of the repeal of the Full Crew Act, and a bill to abrogate the measure is to be submitted to the legislature. It is estimated that the waste resulting from this law has amounted in New York alone to from $2,000,000 to $3,000,000 since the law went into effect in 1913. In Pennsylvania the waste averaged $4,000,000 a year until the people of that state had the law repealed last year. Indiana has stricken a similar law from its statutes. Missouri voted against the measure in the proportion of 2 to 1. In Massachusetts, Oklahoma and Ohio, Full Crew Acts were vetoed by executive action.



Hydraulic Pump Crankshaft which broke at B

CALCULATING THE HORSEPOWER OF SPUR GEARS

By FRED ROSS EBERHARDT, Manager Gear Department
Newark Gear Cutting Machine Co., Newark, N. J.

As electric motors are used more widely for machine and mill drives, there is more frequent occasion to figure the size of gears required, and as motors are rated according to horsepower and speed in revolutions per minute, it is desirable to rate or calculate gears the same way, rather than to figure the breaking strength of the gears at loads in pounds.

The Lewis and Barth formulas are generally accepted as being the most satisfactory for industrial gearing where the pitch-line velocity is under 2000 feet per minute. In their usual forms, however, they are rather cumbersome to use, and it is very easy to make errors. Realizing the inadequacy of the ordinary formulas, a number of charts have been prepared by various engineers. It has been the writer's experience that these charts, as a rule, seem to be simple, but are even more complicated than the arithmetical process required to work out the Lewis formula, or else they are so abbreviated as to be inaccurate.

The following formula, which is based on the Lewis formula, has been arranged to simplify this work, especially for those who frequently have to calculate the power-transmitting capacity of gearing. In this formula

H = horsepower;

S = allowable static unit stress;

W = width of gear face in inches;

Y = outline factor for given number of teeth and pressure angle (see MACHINERY'S HANDBOOK, page 595, for table of factors);

V = velocity in feet per minute at pitch line of gear = 0.262 × pitch diameter in inches × R. P. M.; and

P = diametral pitch.

$$H = \frac{SWYV}{P\,55\ \ (600 + V)}$$

In using this formula, the values of S for accurately cut gears made of different materials are as follows: cast iron, 8000; semi-steel, 9000; U. S. Government bronze, 10,000; 0.30 per cent carbon steel, 15,000; 0.50 per cent carbon steel, 25,000; rawhide, 5000; bakelite, condensite, formica, textoil, etc., 5000.

Example—Find the horsepower that can be transmitted safely by a cast-iron spur gear which is to have 40 teeth of 4 diametral pitch, a 2-inch face width, and a speed of 80 R. P. M. It is assumed that the gear has accurately cut teeth, and the pressure angle is 14½ degrees. Then,

$$H = \frac{8000 \times 2 \times 0.34 \times 210}{4 \times 55 \times (600 + 210)}$$

$$\fallingdotseq \frac{80 \times 2 \times 34 \times 210}{4 \times 55 \times 810} = 6.4 \text{ horsepower}$$

It will be noted that the arithmetical work is reduced somewhat simply by dropping the decimal point from the outline factor 0.34 and at the same time cancelling two ciphers from 8000 representing the static unit stress.

In determining the power-transmitting capacity of spur gears having cut teeth, the following general rules should be considered:

1. The horsepower a gear will transmit depends upon the quality of the material, accuracy of the teeth, rigidity of shafts, bearings, and housings, and the accuracy of the shaft alignment.

2. A gear supported on only one side should be made with a comparatively narrow face, a good rule being to make the face width in inches equal to 10 ÷ diametral pitch.

3. The gears should always be made *strong* enough; that is, they should be capable of transmitting at least 25 per cent more than the rated horsepower. The reason for this is that everything mechanical is subject to overload from one cause or another. If the drive is subject to a known overload, the gears should be made strong enough for the full overload, plus about 25 per cent for safety. Gears for crushers, rolls, and reciprocating pumps must often be made capable of carrying 250 per cent of the normal or rated load.

4. While it is possible to make spur gears with as few as three teeth, it is well known that small numbers of teeth are not satisfactory for high-speed or hard work. As a rule, it is not practical to use a pinion with less than 18 teeth, when the pitch line velocity exceeds 800 feet per minute.

5. When the gears are of rigid construction, mounted on rigid shafts supported on both sides of the gear face, and run in oil, a pitch-line velocity of 2000 feet per minute is permissible in some cases. Usually, however, it is well to keep below 800 feet per minute for metal gears to be used under ordinary conditions. Above 800 feet per minute it is well to use rawhide or bakelite for one of the gears, the other gear being made of metal. If noise is not objectionable, both gears may be made of metal. Strength and quietness can be obtained by making the pinion of laminated construction, using alternate plates of steel and bakelite, riveted together.

* * *

MACHINISTS AND TOOLMAKERS IN THE UNITED STATES

The Bureau of Census of the Department of Commerce has just completed a compilation of the number of machinists and toolmakers in the United States, classified according to states. From this compilation, as given in the accompanying table, it appears that in 1920 there were over 800,000 machinists and 55,000 toolmakers in the country, as compared with 461,300 machinists and 9240 toolmakers in 1910.

The twelve leading states as regards the number of machinists employed, in the order of their importance, are New York, Pennsylvania, Ohio, Illinois, Michigan, Massachusetts, New Jersey, California, Indiana, Wisconsin, Connecticut, and Missouri. The twelve leading states as regards the number of toolmakers employed are Michigan, New York, Ohio, Connecticut, Massachusetts, Illinois, New Jersey, Pennsylvania, Wisconsin, Rhode Island, Indiana and Missouri.

MACHINISTS AND TOOLMAKERS IN THE UNITED STATES ACCORDING TO 1920 CENSUS

State	Machinists	Toolmakers and Die-Sinkers	State	Machinists	Toolmakers and Die-Sinkers	State	Machinists	Toolmakers and Die-Sinkers	State	Machinists	Toolmakers and Die-Sinkers
United States	801,896	55,089	Illinois	63,889	4,098	Montana	2,142	5	Rhode Island	10,899	1,387
Alabama	6,821	29	Indiana	28,188	1,341	Nebraska	3,984	23	South Carolina	2,901	7
Arizona	1,599	8	Iowa	10,200	234	Nevada	634	7	South Dakota	1,154	.....
Arkansas	2,200	10	Kansas	6,852	39	New Hampshire	4,047	96	Tennessee	6,483	31
California	32,465	350	Kentucky	7,509	144	New Jersey	40,729	3,733	Texas	11,342	49
Colorado	4,807	54	Louisiana	3,928	22	New Mexico	1,112	3	Utah	1,964	.....
Connecticut	22,634	6,106	Maine	5,306	71	New York	100,565	7,831	Vermont	2,909	68
Delaware	2,772	39	Maryland	11,776	289	North Carolina	5,769	10	Virginia	10,313	83
District of Columbia	4,108	227	Massachusetts	55,128	4,702	North Dakota	945	2	Washington	9,288	124
Florida	3,777	24	Michigan	60,878	11,794	Ohio	78,844	6,582	West Virginia	4,810	75
Georgia	6,804	30	Minnesota	10,653	173	Oklahoma	3,818	10	Wisconsin	26,085	1,421
Idaho	1,345	3	Mississippi	2,066	9	Oregon	4,491	48	Wyoming	1,177	1
			Missouri	16,261	554	Pennsylvania	93,525	3,143	.....	.....	.....

Machinery

The Machine-building Industries

THE gradual improvement in the machine tool business referred to in this review last month continues. In standard lines the improvement is very slow, and in some lines it is not perceptible; but there has been a fair demand for special machinery, and the automotive industries have either placed orders for, or are inquiring about, a fair amount of new equipment.

One of the most encouraging signs is the increased activity in the iron and steel field, which always, in due course, brings about a demand for machine tools and other shop equipment. About the middle of April the average operation in this industry was close to 75 per cent, the United States Steel Corporation in the Chicago district operating at 80 per cent of capacity, and the steel works in the Pittsburg district running close to 70 per cent. A very large part of the demand comes from the railroad field, hundreds of thousands of tons of steel being required for railroad cars and locomotives that have been ordered recently. Extensive repair work on the great number of freight cars out of commission also increases the demand for steel, and the building of new cars and locomotives and the repairing of old ones will naturally put into operation existing machine tool equipment and probably create some new demand.

Conditions in Different Branches of the Industry

The volume of business in the tool and contract field is increasing materially; but conditions are not satisfactory, because the prices quoted are too low and competition is not based on an accurate knowledge of costs. A number of the tool shops started during the war have gone out of business; but there are still a great many more shops of this type than present conditions warrant, and it is expected that there will be a further reduction in their number.

In the gear industry conditions are 'spotted.' This business has had its ups and downs during the entire depression. The makers of automobile gears are experiencing a steadier demand, and one of the largest gear manufacturers in this field is running over 50 per cent of the maximum capacity; this represents a business considerably in excess of the pre-war output of this company.

In the die-casting field there has been a substantial improvement, especially in the demand for new dies. The die-making departments of some of the die-casting plants are working overtime; others are occupied at about 100 per cent with regular time and force. The production of die-castings is not quite so active as die-making, but the improvement even in this field is noteworthy. Present activity in some plants is well over 50 per cent of capacity.

The ball-bearing industry shows signs of greater activity. One well-known maker states that while the present demand is only from 35 to 40 per cent of maximum capacity it is 50 per cent greater than the average demand for 1921. This statement is borne out by the conditions in the ball making factories, which have experienced a similar improvement.

The process of finding an outlet for the excess shop capacity in the machine tool and special tool field is making progress. In addition to the activities previously mentioned in past months in this review, some plants are turning to automobile accessories, watchmakers' machinery, truck parts, radio parts, etc., to keep their shops at least partly busy.

A constantly increasing interest in high-production and cost-reducing machinery and devices is being taken by manufacturers in general, particularly in the automobile field. The maker of a line of machine tools especially suitable for plants where high production counts, has for years tried to interest one of the largest and best-known automobile plants in his machines; but it was only recently that he was successful in gaining even an opportunity to demonstrate what his machines can do. The reduced prices on cars make it necessary for the builders to investigate every possible means of reducing manufacturing costs.

In the general machine-building field there has been a substantial demand for road-building and excavating machines, and some plants that ordinarily produce other equipment for which there is but a small demand at present, are keeping partially busy by diverting their organization and equipment to the building of such machinery. A large hydraulic pressed steel concern reports a definite business improvement in all of its plants.

The Automobile Industry

In the automobile industry there seems to be more confidence than there has been for the last eighteen months. It is true that automobile plants are now running at a higher rate than the average for the year, due to the seasonal demand, but the buying of dealers is said to be generally for actual sales rather than for stock.

The number of automobiles registered in the United States during the last twenty years, according to figures compiled by the Automobile Chamber of Commerce, are of considerable interest. In 1900 there were less than 14,000 automobiles registered. In 1905 this number had risen to 78,000, and in 1910 to 468,000. In 1915 there were close to 2,500,000 cars; in 1920, 9,211,000; and in 1921, 9,245,000. The schedule for the April production of Ford cars calls for over 90,000 automobiles. The total production of automobiles during February, according to the Department of Commerce statistics, was 109,005 passenger cars and 12,898 trucks.

The Truck and Tractor Industry

In the motor truck industry there has been an increase in the number of orders received, and an optimistic feeling prevails among truck manufacturers and dealers. The buying is more conservative than it was two years ago, and manufacturers have to make prompt shipments in order to close sales. There has also been a definite change for the better in the automobile parts business, but buying is largely for immediate requirements.

The tractor industry begins to show signs of improvement. One of the largest tractor builders in the Middle West reduced a stock of 5000 tractors to 400 during the fall and winter, and at that point began to operate on a manufacturing schedule of 75 tractors a day to replenish its stock. In the general farm machinery line, there has been but a slight change, but the Federal Reserve banks state that the reports from the agricultural sections are growing more favorable and that a spring demand is in evidence.

The Influence of the Radio Business

The demand for radio apparatus has created a considerable business for shops having suitable equipment for this kind of work. Small sizes of hand and automatic screw machines and power presses are needed chiefly for making the parts for receiving sets. Some of the machine tool builders have obtained business from this source, but much of the work is done by existing plants having the necessary equipment, a large part of which is idle on account of the general depression in the metal-working field. There will doubtless be a considerable volume of business in the radio field for some time to come, and if all the manufacturers of radio apparatus begin to make their own parts, instead of buying them from other concerns, there will be a demand for new machinery from this industry.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

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Brown & Sharpe Micrometer Caliper. Brown & Sharpe Mfg. Co., Providence, R. I..... 760
Betts Boring and Turning Mill. Betts Machine Co., 400 Blossom Road, Rochester, N. Y..... 760
Excelsior Angle-iron Bending Machine. Excelsior Tool & Machine Co., 30th St. and Ridge Ave., East St. Louis, Ill..... 760
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Blanchard Vertical-Spindle Surface Grinding Machine

PROBABLY the heaviest and most powerful vertical-spindle surface grinding machine ever built has been developed by the Blanchard Machine Co., 64 State St., Cambridge, Mass. This machine weighs about 30,000 pounds, is 12 feet 6 inches long, 7 feet 6 inches wide, and 10 feet high. In general arrangement it is similar to the No. 16 Blanchard grinding machine. The work is carried on a rotary magnetic chuck, which is moved horizontally from the loading to the grinding position, and then rotates continuously while the grinding wheel is gradually being fed downward. The chuck and table of the machine are traversed by power.

The grinding wheel is held by sulphur in a cast-iron retaining ring attached to the faceplate by six screws, and is wire-banded. The wheel-head weighs three tons and has a sixty-horsepower induction motor built into it, which runs at a speed of 600 revolutions per minute. The rotor is mounted directly on the wheel-spindle, which is carried in two large radial-thrust ball bearings. A spring take-up at the upper end exerts an upward pull on the spindle that exceeds the weight of the rotating parts by about 1000 pounds. This initial load on the lower or main thrust bearing serves to eliminate all play or backlash. The main bearing has a rated thrust-load capacity of over 25,000 pounds. Fig. 3 shows the principal parts of the wheel-head, with a man of average height standing behind them to give an idea of their size. The main ball bearing is in the left foreground of the illustration.

The wheel-head slides vertically on the column, this movement being controlled by a feed-screw carried in ball bearings in the column. The feed-screw is driven through a gear-box, the mechanism of which is driven by the upper pulley at the right end of the machine. The latter may be clearly seen in Fig. 2. Double friction clutches provide for the rapid raising or lowering of the wheel-head. Both hand and power feeds are obtained by means of the box on the front of the column. The power feed has an automatic stop, and is supplied with a convenient adjustment which gives feeds of from 0.0005 to 0.005 inch per revolution of the chuck. One lever controls the engagement of the power feed and the raising and lowering clutches, the lever being so designed that these cannot be simultaneously engaged. The hand feed is 0.010 inch per crank revolution.

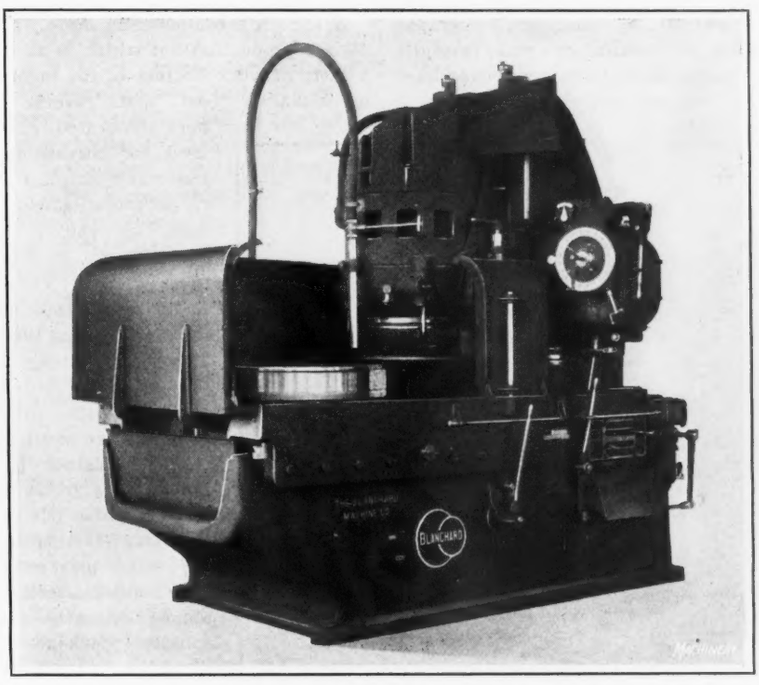


Fig. 1. No. 27-R High-power Vertical-spindle Surface Grinding Machine built by the Blanchard Machine Co.

The wheel has a safety guard constructed of 5/16-inch steel plate which is supported on three steel rods, and it has a convenient rack-and-pinion mechanism for vertical adjustment. A dresser attached to the wheel-head provides for truing the wheel face while grinding. Water is supplied to the inside of the wheel through a 2-inch pipe and to the outside nozzle through a 1½-inch pipe. The column is fastened to the base by means of the usual Blanchard three-point support, which makes it easy to maintain proper alignment of the column.

The large pulley, seen in Fig. 2 near the base of the machine, transmits power for rotating the chuck, while the pulley to the right of it drives the water pump and the table-traversing mechanism. The chuck is driven through a four-speed gear-box having sliding gears and a friction clutch for starting and stopping. This clutch is interlocked with the gear-shifting mechanism. Power for all purposes, except driving the grinding wheel, is supplied by a 5-horsepower motor on the back of the column. The rotary magnetic chuck is of the one-piece steel type, and has closely spaced holes suitable for holding either small or large work. The face is made of brass and steel, and is waterproofed.

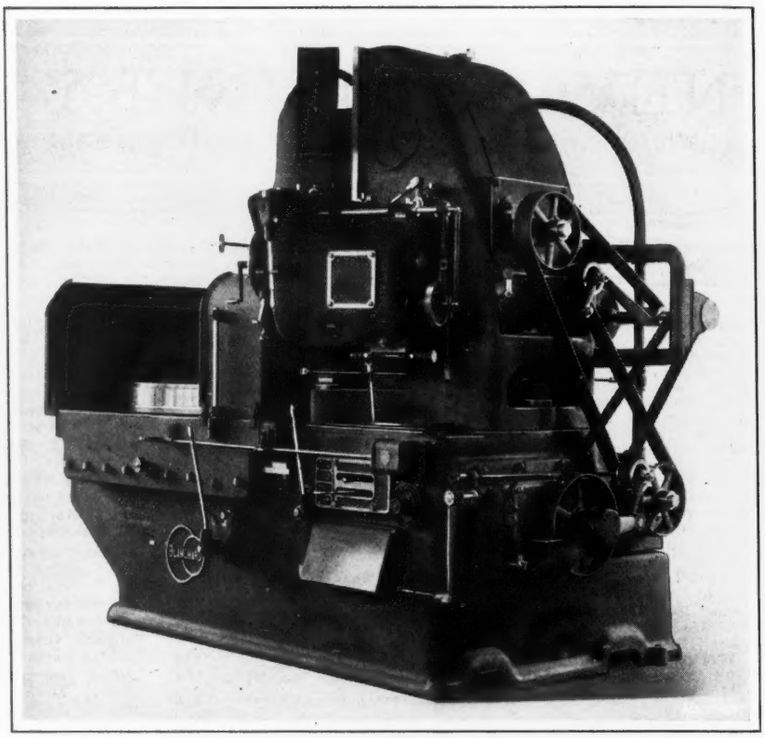


Fig. 2. Right-hand End of Blanchard Grinding Machine, showing Drive to Various Units

The chuck is caried on a table sliding on one flat way and one V-Way on the base. The table spans the base in such a way that all water and chips from the work fall directly into the first part of the water tank in the base. Here most of the solid material settles to the bottom, and the water overflows into the rear part of the tank where any remaining material settles. The water then flows under a skimmer which retains floating dirt and over another dam into the pump tank. The main tank is designed to facilitate cleaning. Both parts are so arranged that the entire bottom can be reached with the hoe provided, and an incline leading to an overhanging drip edge makes it easy to remove dirt into any receptacle. The pump tank holds 425 gallons.

Water guards made of ⅛-inch steel plate entirely surround the work and the grinding wheel. The section on the front of the machine was removed at the time the photographs were taken. The question of lubrication was carefully studied in the designing stage. Both main gear-boxes have pressure-feed lubrication from submerged gear pumps to every bearing. Other important units have a reservoir of oil with means for circulating or splashing to all bearings.

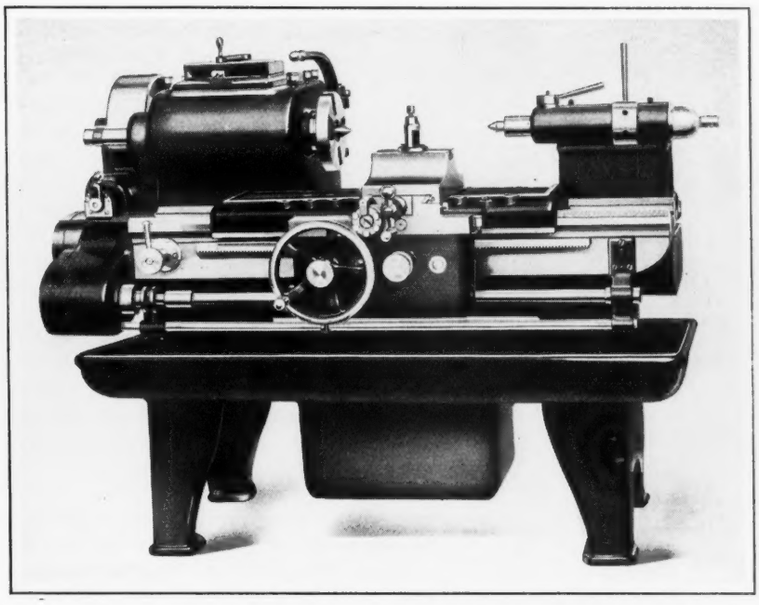
Some of the specifications of this machine are as follows: Range of work with a standard 42-inch chuck, 48 inches in diameter by 20 inches high; with an over-size 48-inch chuck, 48 inches in diameter and 16 inches high; maximum swing inside of water guards, 60 inches; wheel size, 27 inches in diameter by 7 inches thick and 2 or 3 inches width of rim; wheel speed, 580 revolutions per minute or 4100 feet per minute; and chuck speeds 3, 5, 8, and 13 revolutions per minute.

Fig. 3. Principal Parts of the Wheel-head

SUNDSTRAND HEAVY-DUTY MANUFACTURING LATHE

A 12-inch manufacturing lathe which is intended for specialized production but which is also suitable for handling a variety of work because of the incorporation of a cross-feed, quick-change feed and reverse to the carriage, is here illustrated. This machine can also be used for thread-cutting by substituting a lead-screw in place of the feed-rod. It has recently been added to the line of equipment built by the Rockford Tool Co., 2400 Eleventh St., Rockford, Ill. The bed is of the patented construction employed in Sundstrand lathes, having separate ways for the carriage, and the headstock and tailstock. This design allows the carriage to travel to the end of the bed in front of the tailstock and eliminates overhang of the tailstock spindle when short work is being supported.

The headstock is of the selective-speed type, and is driven by a single pulley furnished with a friction clutch. The clutch-operating lever is conveniently located, and the same movement that disengages the clutch automatically applies a brake which almost instantly stops the spindle. Nine spindle speeds are obtainable by means of two levers on top of the headstock, which operate sliding gears. The spindle can be locked by a plunger at the front end of the



Sundstrand Twelve-inch Manufacturing Lathe built by the Rockford Tool Co.

headstock, so that chucks and faceplates may be conveniently removed. The spindle has a hole running through its entire length, and the rear end is extended to permit the attachment of an air cylinder, draw-in attachments, expansion chucking device, etc.

The carriage has an exceptionally long bearing surface on the ways, and is arranged with a slide-block for a taper attachment. Provision is also made for mounting extra cross-slides, special tool-holder blocks, and similar attachments. A multiple stop collar furnishes a positive stop for the cross-slide when turning shafts with shoulders.

The apron is of the double-wall type, and so designed that a lead-screw can be substituted for the feed-rod. Practically all standard threads may be cut after such substitution, by the use of a few additional change-gears. The main feed-shaft or the lead-screw is connected to the feed-box shaft by means of a sliding clutch operated from a trip-rod on which collars can be placed at any point to stop the carriage movement automatically. The taper attachment is conveniently placed below the carriage, where it can easily be reached for adjustment.

A tool placed on the rear ways of the bed between the headstock and tailstock works simultaneously with the carriage, being driven by means of a rack fastened to the carriage. The tailstock is of a quick-acting design. The motor is attached to the rear of the bed, a silent chain transmitting power from the motor to the main driving shaft. An eccentric bushing provides for taking up slack of the chain.

Some of the specifications of this lathe are as follows: Swing over carriage, 12 inches; maximum distance between centers, 18 inches; diameter of hole through spindle, 1 11/32 inches; length of carriage on bed, 34 inches; number of feeds, 29; range of feeds, from 0.005 to 0.043 inch; range of spindle speeds, from 36 to 251 revolutions per minute; and weight of machine, 3130 pounds.

SENECA FALLS LATHES

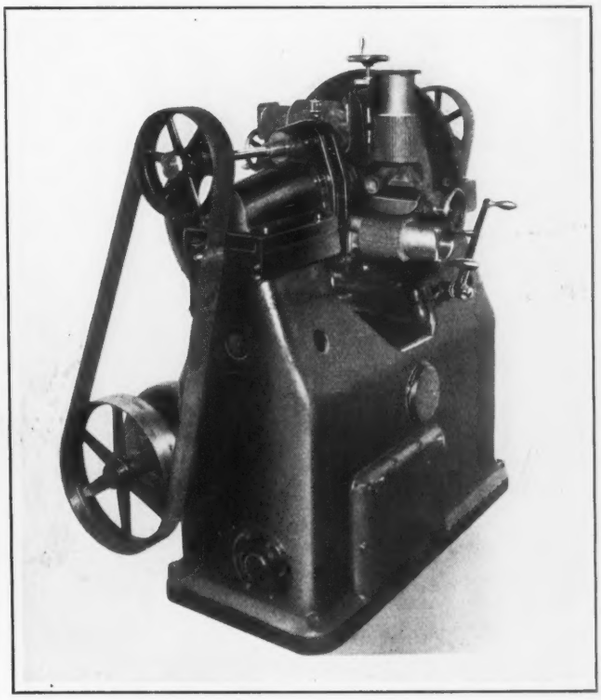
A line of engine lathes designed especially for the radio industry and automobile service stations is being made in various sizes ranging from 9 to 13 inches swing by the Seneca Falls Mfg. Co., 381 Fall St., Seneca Falls, N. Y. These machines are sold under the trade name of "Handy," and are similar in design to the gap-bed lathe described in February, 1920, MACHINERY, with the exception of the bed. The latter corresponds to the bed provided on the lathe described in April, 1919, MACHINERY. These lathes may be arranged for either belt or motor drive.

The same company is placing on the market a plain turning lathe, not provided with thread-cutting equipment. This machine will be of particular interest to the manufacturers of small electrical apparatus. It has a swing of 10⅛ inches, takes work up to 12 inches long between centers, and has feeds of from 0.002 to 0.040 inch per revolution of the spindle. It has a three-step cone pulley.

SEMI-AUTOMATIC TWO-WAY BORING MACHINE

A semi-automatic two-way boring machine designed primarily for boring, bottoming, and reaming the intake and exhaust ports of gas-engine cylinders, but which is also adaptable to similar operations on other work, is a product of the Manufacturers' Consulting Engineers, McCarthy Bldg., Syracuse, N. Y. An indexing fixture at the middle of the machine receives four pieces of work at one time. The work is clamped on the fixture in any of the four positions by tightening up a handwheel. The cutters are mounted in two multiple heads, which are placed on opposite sides of the fixture. Each head is supplied with three cutters. The two heads are fed simultaneously toward the work, and each time this movement is made, an operation is performed on three of the cylinders. At the same time the fourth is unloaded and a new one substituted. There is plenty of time between movements of the cutter-heads for reloading.

The feed of the cutter-heads is started by throwing in the clutch through the operation of a hand-lever at the front of the machine. One piece is completed every twenty seconds. The holes reamed in the work are 1 9/16 inches in diameter and 1 inch long. The motor for driving the machine is placed inside the base and drives a shaft running the length of the machine at the rear, which has a pulley on each end. Power is transmitted from the motor to this shaft through a chain and sprockets, and the pulleys on the ends of the shaft transmit the drive to the cutter-heads.



Motor-driven Semi-automatic Two-way Boring Machine brought out by the Manufacturers' Consulting Engineers

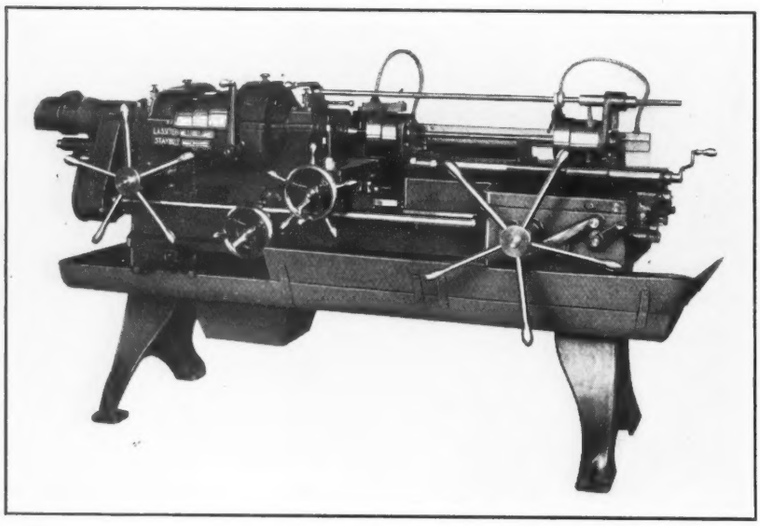


Fig. 1. Staybolt Machine built by the Millholland Machine Co.

The main driving shaft has a worm near the middle which drives a worm-wheel on a shaft having two cams. These cams actuate lever arms connecting with the cutter-heads and cause them to reciprocate to and from the work. A trip on the camshaft throws out the clutch at the completion of each cycle and stops the movement of the cutter-heads. The latter slide on ways similar to those of a shaper, and the work is positively held in alignment with the cutter-heads by the shaft on which the work-fixture is mounted. Each cutter has a multiplicity of cutting edges, which permits the use of a rapid feed per revolution.

LASSITER-MILLHOLLAND STAYBOLT MACHINE

Increased steam pressures in locomotive boilers have necessitated that the thread of staybolts used in their construction be uniform in pitch and that the lead of the threads on each end be continuous relative to each other. With the staybolt machine illustrated, a continuous lead is assured, as the machine slide is fed by a lead-screw in cutting the threads. This machine is built by the Millholland Machine Co., 1102 W. 23rd St., Indianapolis, Ind., and the Dale Machinery Co., Inc., 17 E. 42nd St., New York City, is the exclusive selling agent. The machine is built in two types, a Model A for rigid side staybolts, which have straight threads cut on both ends, and a Model B, for radial, flexible button-head, and crown staybolts, which have a straight thread on one end and a taper thread on the other or head end.

Fig. 2. Threading a Staybolt on the Lassiter-Millholland Model A Machine

Fig. 1 shows a Model B machine of the cone-pulley type; this machine is also furnished in a geared-head motor-driven design. The three-step cone and back-gears of the headstock give a range of nine spindle speeds. Changes in spindle speeds are made through friction clutches without stopping the spindle. The staybolt forgings are gripped by the square end in a special collet having an adjustable stop. The main slide has two "modern" die-heads, the forward one of which is mounted in a permanent position on the slide, while the rear die-head is adjustable longitudinally by means of a fine-pitch screw. This adjustment adapts the die-heads for cutting staybolts of various lengths. An accurate spacing bar facilitates the setting of the two heads to cut a continuous lead when changing the position of the heads to suit a new job. The die-heads open sufficiently to permit a button-head to be passed through them to the chuck. A V-block on the slide prevents a staybolt from dragging in the die-chasers when the heads are open.

The first operation on staybolts of this class is to turn the surfaces to be threaded. For this operation the die-heads are provided with solid cutters. The cutters of the front die-head are tapered, and this die-head is also equipped with a taper attachment which gives its cutters a slight opening movement as it is fed forward. Both die-heads are opened automatically at the proper instant, and are closed by adjustable cams on a bar at the rear of the machine. During this operation the slide is fed forward at a rapid rate by means of a rack and pinion mechanism, actuated by a long lever on the apron which operates a friction clutch.

For the threading operation on the staybolt ends, chasers may be substituted for the cutters in the die-heads, although in shops where large quantities of staybolts are produced, it is generally preferable to use a second machine for the threading operation. The front die-head is equipped with tapered chasers. The two die-heads are held in a constant relation on the slide, and the latter is fed forward by two half-nuts in the apron which engage the lead-screw. Feeding the slide by means of the lead-screw prevents the die-heads from lagging or creeping.

Because of the different lengths of the surfaces machined, the rear die-head, both in turning and threading, advances about 1½ inches along its corresponding surface before the cutters or chasers of the front die-head begin cutting. This makes it unnecessary to support the rear end of the bolt on a center. The cross-slide is intended for use in facing the under side of the button-head, and may or may not be furnished. Change-gears can be furnished for cutting threads of any standard pitch. This machine has a capacity for staybolts from ¾ to 1½ inches in diameter and 14 to 36 inches in length. The maximum turning length is 5 inches. The net weight of this machine is 3500 pounds.

The Model A machine is intended for producing staybolts from bar stock fed automatically through the headstock spindle. The main slide of this machine is equipped with a turret on which are mounted a stock stop, single-cutter roller box-mill, and a "Modern" automatic self-opening die-head as shown in Fig. 2. After the stock has been fed to the stop, the turret is indexed to bring the box-mill in line with the work. The turret-slide is then fed forward, and during the feeding movement, the portion of the bolt between the ends to be threaded is relieved by the box-mill. The feeding movement is accomplished by means of the rack and pinion mechanism mentioned in connection with the Model B machine.

After the turret-slide has been returned to its original

position, the turret is again indexed to bring the die-head in line with the work. The die-head having been closed, the two apron half-nuts are engaged with the lead-screw. Then the slide is fed forward to enable the die-head to cut threads on both ends of the staybolt, during which operation the die-head cannot lag or creep. Fig. 2 shows this operation in process.

As the die-head completes the thread on the first end, the machine is speeded up instantly by means of a friction clutch in the headstock so as to feed the die-head quickly over the relieved portion of the staybolt. When the die-head approaches the opposite end of the staybolt, the machine is again slowed down before the chasers begin cutting the thread. The die-head is automatically opened when the thread is completed. The turret binding bolt has a hole which permits the staybolt to project through the turret. The finished staybolt is cut off from the stock by the tool on the cross-slide. This machine regularly has a capacity for staybolts up to 1⅝ inches in diameter, but it can be arranged for handling work up to 2¼ inches in diameter. The maximum over-all length of staybolts that can be machined is 12 inches. The net weight of this machine is 3000 pounds.

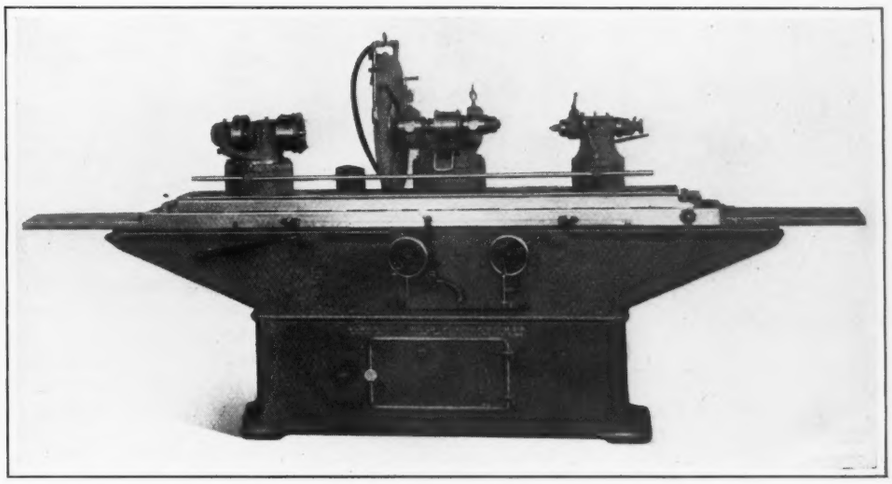


Fig. 1. Grinding Machine brought out by the Brown & Sharpe Mfg. Co. for Automotive Parts, in Addition to Regular Straight and Taper Work

BROWN & SHARPE UNIVERSAL AND CRANKSHAFT GRINDING MACHINE

Automotive crankshafts, pistons, wrist-pins, valve seats and stems, etc., in addition to the regular straight and taper work which a universal grinding machine is capable of handling, may be ground on the No. 4 universal and crankshaft grinding machine here illustrated. This machine has been recently brought out by the Brown & Sharpe Mfg. Co., Providence, R. I., to meet the requirements of motor service shops. Internal and face grinding can also be accomplished on such parts as individual cylinders, clutches, and transmission gears, by means of an internal grinding attachment and chuck. In fact, with the exception of cylinders cast en bloc, all ordinary parts of automobile engines can be ground. Furthermore, the machine can be employed for grinding line reamers, milling cutters, centers, boring-bars, and other tools.

Successful crankshaft grinding depends to a great extent upon the accuracy with which the throw-blocks are constructed. For this reason, the throw-blocks on this machine are made to tool-room accuracy. Their sides are finished relative to the center holes in the sliding blocks. This permits a crankshaft to be readily aligned by placing the blocks on their sides on a surface plate. The blocks are provided with adjustable clamp caps so that crankshafts of various diameters can be accommodated, three center holes for crankshafts of different throws, and an adjustable slide for obtaining a fine adjustment. The sliding block used on the headstock end of a crankshaft has a special extension which, with its recess, provides for grinding flanged crankshafts.

Another noteworthy feature of the machine is the piston arbor, by means of which a piston, in addition to being mounted on dead centers, is ground on its own centers. This method not only insures accuracy, but also enables a used piston to be trued up concentric with the axis on which it was first machined. For valve grinding, the wheel-slide is set at the desired angle, and the corner of the wheel moved across the valve seat. After the wheel-slide has been set, the table remains stationary, the wheel being traversed across the valve seat by the cross-feed.

Aside from the few special features necessary to fit the machine for its particular purpose, the construction is similar to that of the regular No. 4 Brown & Sharpe universal grinding machine. By removing the raising blocks from under the headstock and footstock, changing the size of the grinding wheel and its guard, and making slight additions to the equipment, the machine can be converted into the regular type.

The wheel-spindle is made of tool steel and runs in self-aligning phosphor-bronze boxes provided with means of compensating for wear. The spindle and its boxes can be easily removed to make room for the internal grinding attachment, as shown in Fig. 3. The automatic cross-feed moves the wheel from 0.00025 to 0.004 inch per reversal of the table. It is automatically disengaged when the work has been ground to size. The table travel is also automatic, being controlled by adjustable dogs. The speed and feed of the wheel, the speed of the work, and the table feed, are entirely independent of each other. A single lever is operated to start or stop the rotation of the work and the feed of the table. The table-reversing mechanism permits of grinding work close to shoulders.

The base of the machine rests on the floor at three points. This maintains the alignment of the table, even though the floor may not be absolutely level. Ample overhang at each end of the bed gives a firm support for the table, especially at the end of its traverses. Included in the equipment are back-rests for supporting slender work or splined shafts, as shown in Fig. 2. These rests are universal in all movements.

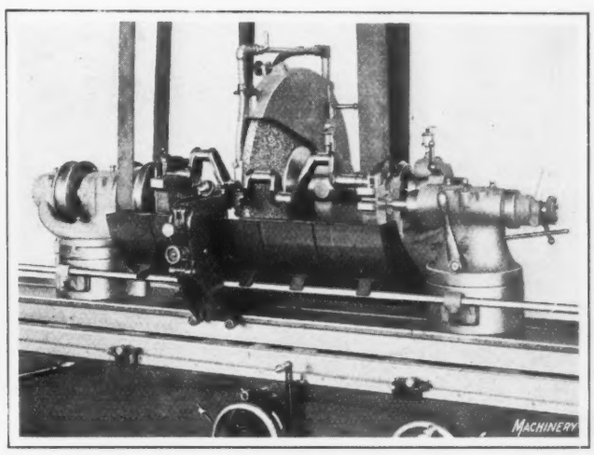


Fig. 2. Grinding a Crankshaft supported during the Operation by a Back-rest

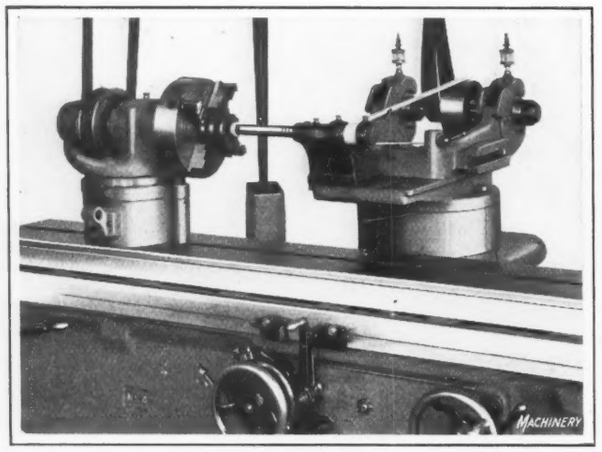


Fig. 3. Internal Grinding made Possible by substituting an Attachment for the Wheel-spindle and its Boxes

and have close adjustments. They automatically compensate for a decrease in diameter as work is ground to size.

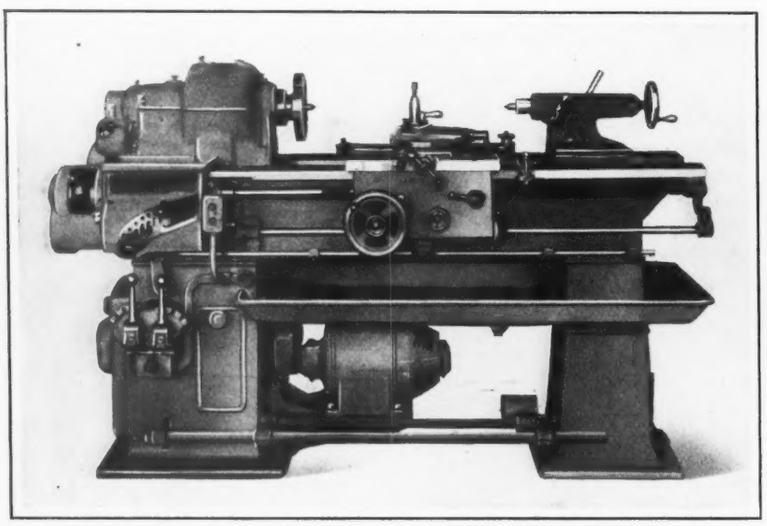
The grinding wheel is 24 inches in diameter, 1 inch thick, and has a hole 5 inches in diameter. It is protected by a heavy guard which confines the spray and particles of abrasive. The footstock carries a holder for the carbon point, by means of which the wheel can be trued without removing work from the centers. Work up to 20¾ inches in diameter and 60 inches in length may be placed on the centers.

HENDEY MOTOR-DRIVEN LATHE

In the 1922 model 14-inch lathe of the Hendey Machine Co., Torrington, Conn., the motor has been placed beneath the oil-pan and the drive is through a speed-box in the left-hand pedestal and thence through a belt to the headstock spindle. By means of this driving arrangement, the lathe retains all the desirable features of the cone type and secures most of the advantages of the geared-head type. Eighteen spindle speeds are obtainable, nine through the speed-box in the pedestal and nine through the customary back-gears in the headstock. Reducing gears are located in the drive between the motor and the speed-box. The latter is oil-tight.

All driving parts of the lathe are enclosed, with the exception of the lead-screw and the faceplate, so as to protect the operator and the machine from injury. The interior of the headstock and speed- and quick-change gear-boxes may be conveniently exposed by the removal of a manhole or cover-plate. The headstock is equipped with a taper spindle and bearings, and is provided with means for taking up end play of the spindle. The single pulley and pinion run on a sleeve readily supplied with oil. An intermediate sliding feed-gear is operated through a conveniently located lever. The back-gear quill may be oiled while in motion. The carriage and compound rest are of improved design, and the tailstock has a graduated sleeve and effective clamping means.

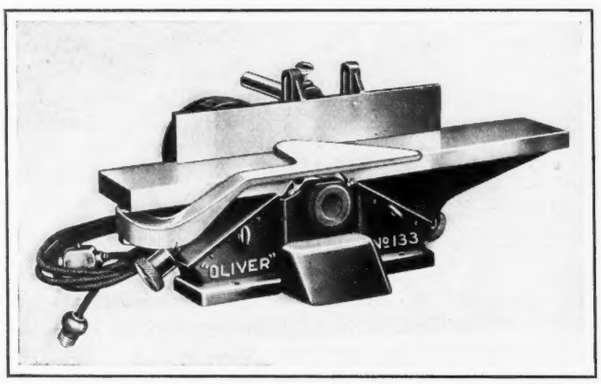
The motor is controlled by push-buttons. An interlocking mechanism between the shifting levers and the starting panel enables the speed of an alternating or direct-current motor to be reduced automatically while gears are being shifted. Supplementary control of the spindle is obtained through a treadle running the full length of the bed. Pressure on this treadle instantly causes the spindle to stop rotating, and permits quick examination or calipering of work. The tension on the driving belt may be altered by means of a single-screw adjustment.



Motor-driven Lathe placed on the Market by the Hendey Machine Co.

OLIVER HAND PLANER AND JOINTER

The work of patternmakers in jointing and fitting small patterns, is facilitated by the portable motor-driven hand planer and jointer shown in the accompanying illustration. This machine is now being placed on the market by the Oliver Machinery Co., Grand Rapids, Mich. It is made in two sizes, 6 inches and 4 inches, which plane to a width of 6¼ and 4¼ inches respectively, and rabbet up to ½ inch.



No. 133 Hand Planer and Jointer added to the line of Patternmaking Equipment built by the Oliver Machinery Co.

The tables are mounted on inclined dovetailed ways on which they are raised or lowered by means of a handwheel and screw. They may be easily locked in any position. The fence can be quickly adjusted across the tables and tilted and locked in any position up to 45 degrees. When not in use, the fence can be swung out of the way of the knife jointing and setting attachment with which the machine may be furnished.

An automatic aluminum guard keeps the unused portion of the knives covered. The cutter-head is of the three-knife circular safety type fitted with three tungsten-chromium knives, ⅛ inch thick and 1 inch wide. The cutting diameter of this head is 3½ inches. The head is direct connected to the motor by means of a universal coupling and runs in self-aligning ball-bearings.

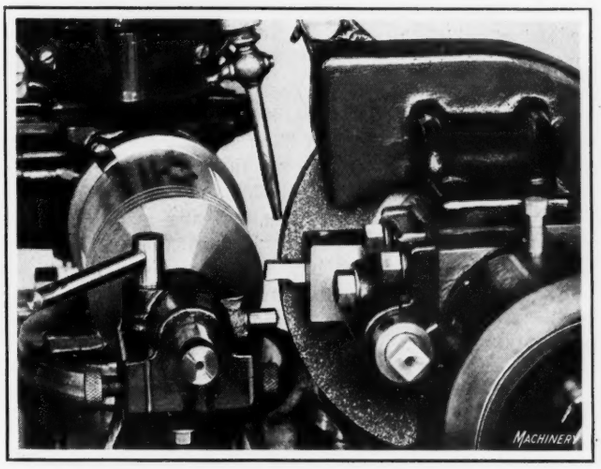
A ¼-horsepower motor is supplied for the 4-inch machine, and a 1/3-horsepower motor for the 6-inch machine. Power for the motor may be taken from a lamp socket, the current supply being controlled through a push-button switch. The machine may be furnished with a rabbeting arm which is mounted on the in-feed table. The knife jointing and setting attachment previously referred to consists of a right-angle way with a sliding block, jointing stone, and

aluminum guard. It serves as a guide for setting the knives, and by sliding the jointing stone back and forth while the cutter-head revolves, the knives are sharpened and jointed. This machine may also be provided with a floor stand.

"RE-LI-O" WET GRINDING MACHINE

Machining automobile pistons on a semi-manufacturing basis is one of the operations for which the No. 2 "Re-li-o" grinding machine now being placed on the market by the Van Norman Machine Tool Co., 160 Wilbraham Ave., Springfield Mass., proves especially useful. The machine is like the "Re-li-o" grinding machine described in December, 1921, MACHINERY except that it is equipped for wet grinding and has an improved type of turning-tool holder. Pistons may be finished to size either by grinding only, or by a combined turning and grinding operation. When a considerable amount of metal is to be removed, it may be desirable to run off the larger portion and then grind to size.

A close-up view of the turning-tool holder is shown in the accompanying illustration. This holder can be swung in to and out of the operating position without interfering with the piston set-up or the grinding wheel. In the illustration, the tool is shown in contact with the work. Before bringing



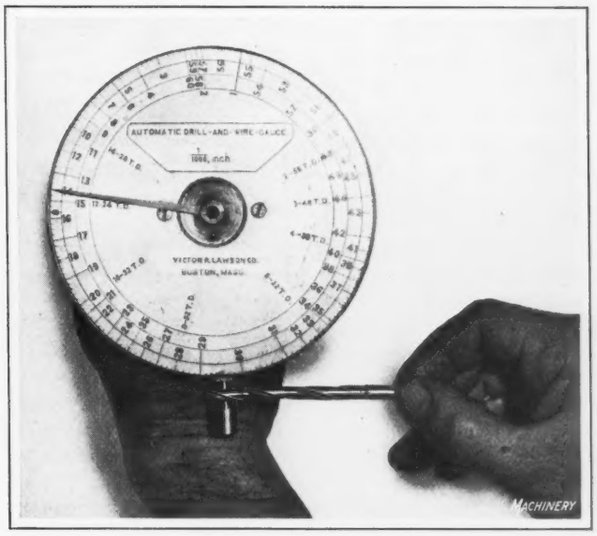
Improved Turning-tool Holder in Use on No. 2 "Re-li-o" Grinding Machine, made by the Van Norman Machine Tool Co.

the grinding wheel into the operating position, the tool-holder is swung downward. An adjustable collar with a locating stop-pin is mounted on the outer end of the tool-holder shank. This stop-pin swings clear when the tool-holder is released and contacts when the tool is swung up for turning. The illustration also clearly shows the diamond truing tool mounted on the rear side of the tailstock. This machine is also suitable for grinding wrist-pins, valves, armature commutators, etc. In addition, it will be found valuable in the tool-room.

LAWSON DIAL DRILL AND WIRE GAGE

Drills and wires ranging from No. 1 to 60 gage can be quickly and accurately checked to see whether they are under or over size, or to determine the gage number, by means of the dial gage illustrated. This device is being introduced to the trade by the Victor R. Lawson Co., 35 Hartford St., Boston, Mass. The graduations on the dial show variations to 0.0005 inch. The dial also shows the proper tap drill to be used for drilling holes that will be tapped to a full thread when the corresponding tap is used.

The drill or wire to be gaged is placed between the two jaws at the bottom of the dial. The upper jaw is stationary, and the lower jaw is attached to a rod which extends into a square groove running across the back of the dial. The lower jaw is normally held in contact with the upper one, but to measure a drill it is depressed by pushing downward

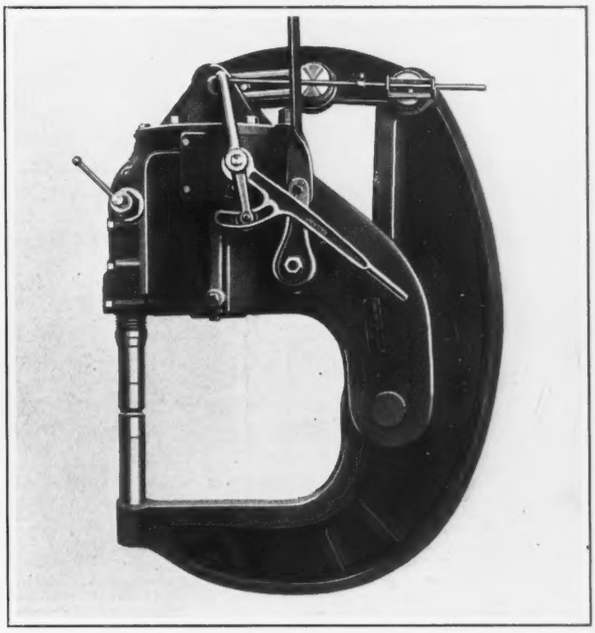


Method of using the Drill and Wire Gage made by the Victor R. Lawson Co.

on the upper end of the rod to which it is attached. In this way the lower jaw may be moved sufficiently to permit a drill to be placed between the two jaws. After a drill has been placed in position, all pressure is released from the sliding rod. The lower jaw then automatically rises into contact with the drill. Movement of the sliding jaw actuates the dial indicator, and so the gage of the drill may be ascertained by observing the position of the indicator. The device is particularly intended for sorting out batches of small drills of mixed sizes. It may be operated by means of a foot-treadle which leaves both hands of the operator free for inserting drills.

SHEPARD PNEUMATIC RIVETING MACHINE

Light and medium structural riveting, such as is done when constructing roof-trusses, plate beam-box, and crane girders; plate and channel or angle columns, etc., is the service for which the "Pinch-Bug" riveting machine here illustrated was designed. This machine is a product of the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. The angular movement of the machine is small, owing to the



Shepard Pneumatic Riveter made by the Hanna Engineering Works

long radius from the hinge-pin to the die axis. When the machine is suspended with the dies vertical and the cylinder up, the upper die does not move as the rivet is driven. The rivets are put in from the top and driven from below. They may be inserted in advance of the machine, and it is thus possible for the man who inserts the rivets to devote some of his time to other details without interrupting the continuous operation of the machine.

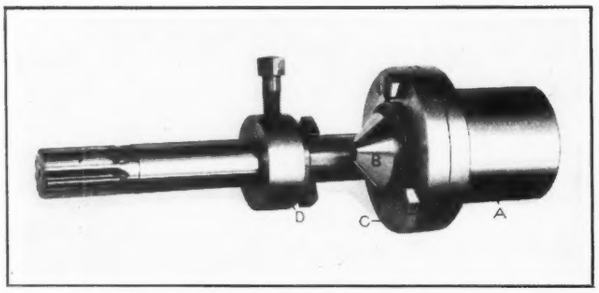


Fig. 1. Non-floating Reamer-holder which is a product of the Marvin & Casler Co.

The suspension pin about which the machine is free to oscillate is so located relative to the center of gravity of the equipment that the machine, when suspended, assumes a position in which the upper die screw is vertical. The die screw remains vertical when the unit is opened or closed, because the center of gravity shifts but slightly during operation. A proper working suspension is easily obtained by hoisting the machine to a position in which the upper die will just rest on the work. The machine has a reach of 20 inches, and a gap of either 11½ or 18 inches, depending on whether a short or a long jaw is supplied. It has a capacity of 50 tons on the dies at an air pressure of 100 pounds per square inch and weighs 1490 pounds.

MARVIN & CASLER PRODUCTS

A non-floating reamer-holder, designed on the theory that in order to ream a straight true hole it is necessary to hold the rear end of the reamer in alignment with the center line of the spindle and the hole to be reamed, has been placed on the market by the Marvin & Casler Co., Canastota, N. Y. This holder may be supplied with an adapter sleeve to fit the turrets of turret lathes, the holder in Fig. 1 being supplied with a sleeve *A* to suit the Jones & Lamson turret lathe. Inserted in the sleeve is a cone-shaped machine-steel center plug *B*.

Before lining up the holder with a piece of work, the latter is first bored to a convenient size to receive the center plug, faced a short distance, and the hole slightly chamfered. Then the adapter sleeve is mounted in the turret with the faceplate *C* held to the sleeve by three cap-screws. The holes in the faceplate for these screws are over-size so as to allow the faceplate to float slightly on the sleeve when the screws are not tightened up. After the center plug *B* has been inserted in the sleeve, the turret is advanced to seat the plug in the hole of the work. While in this position the three cap-screws are tightened to hold the faceplate in position, after which the turret is withdrawn from the work and the reamer-holder collar *D* substituted for the center plug. Only one center plug is required for a group of machines. The reamer-holder collar can be furnished in different sizes.

Fig. 2 shows a T-slot nut which is made in different sizes from ½ to 1 inch by the same company. In many cases work being machined is of such a shape that, when old-style T-slot bolts are employed for holding the work to the table, the bolts must be located before the work is set in place. By employing the nut illustrated, however, bolts may be quickly added for more securely clamping work, even after the machining has begun. The nut and stud used with it are made in sizes to suit the small milling machine slots and the large slots of planers and drilling machines. The nut is so designed that its continuous use does not result in wear of the T-slots.

The use of a line of blocks and jacks, made by the Marvin & Casler Co., in supporting work on a machine platen, is illustrated in Fig. 3. The line consists of a jack and a number of blocks and pipe extensions. The jack has a screw member, one end of which is a point while the other end is a flat surface. At *A* is shown a jack at the top of a pipe extension, with the point end of the screw member uppermost, while at *B* the flat end of the screw member supports the work. The jack body is provided with a flange and is also reversible, the flange permitting the use of the body with the pipe extensions. The location of the flange and lengths of the pipe extensions of a set are such that any height between minimum and maximum may be obtained. When using the point end, the jack alone has a minimum height of 1¾ inches, and when using the flat surface of the screw member, 1½ inches. With four pipe extensions the range of height obtainable is from 1⅜ to 19 inches.

NEW JERSEY FOUNDRY & MACHINE CO.'S "HANDIMAN"

Users of hand-power hoists of 5 tons or greater capacity will be interested in a patented electric machine which may be suspended in the bight of the operating chain of such hoists, for overhauling the chain, which it accomplishes at the rate of 138 feet per minute, with a pull of 150 pounds. This machine is known as the "Handiman" and is manufactured by the New Jersey Foundry & Machine Co., 90 West St., New York City. It is portable so that it may be used with different hoists about the shop.

The machine has a cast-iron housing in which are con-

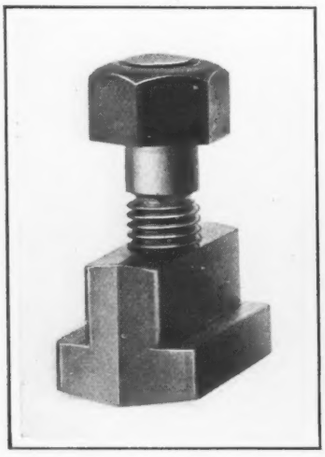


Fig. 2. Casler T-slot Nut

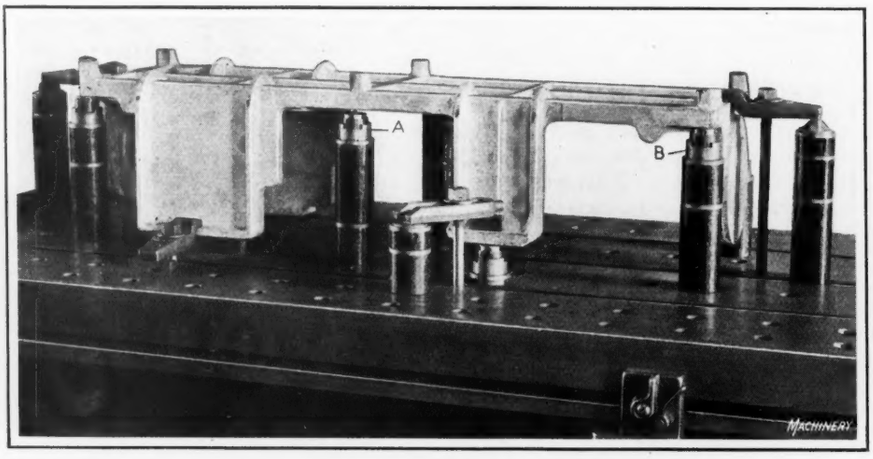
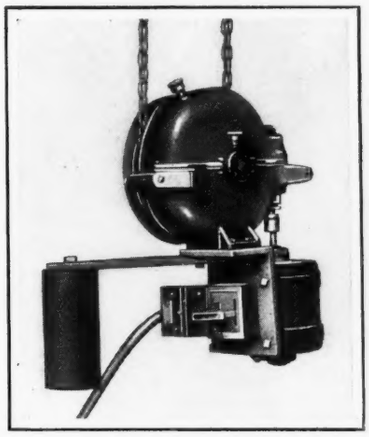


Fig. 3. Supporting Work on a Planer Table by the Use of a Line of Jacks made by the Marvin & Casler Co.



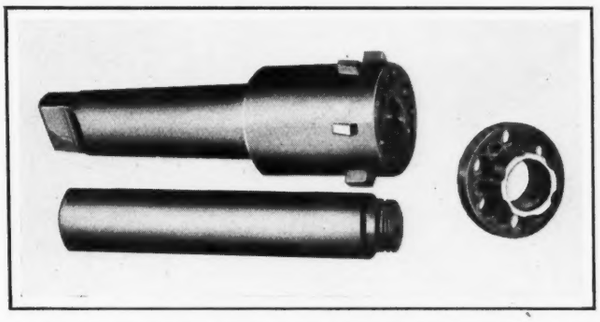
"Handiman" manufactured by the New Jersey Foundry & Machine Co.

tained a worm and worm-gear driven by a ¾-horsepower motor. The worm-wheel shaft extends outside of the housing and carries a grooved sheave having a rubber V-shaped tread which fits any size or pitch of chain and gives a sufficient tractive effort to pull the chain without slippage. The entire unit is so counterbalanced that it hangs in the plane of the chain in which it is mounted.

Current may be supplied from lighting sockets or from a conductor suspended from the hoist, if it is more desirable to bring feeders to that point. A reversing switch provides for running the motor in either direction, for hoisting or lowering. The machine is intended for use in instances where it is desired to obtain faster and easier operation of hoists than is possible by hand, but where the installation of a standard electric hoist would scarcely be warranted.

MADISON ADJUSTABLE BORING HEAD

A boring head intended for both rough- and finish-boring, which can be quickly adjusted by means of a center-pin having a dial graduated to 0.001 inch, is made by the Madison Mfg. Co., Spring and Elton Sts., Muskegon, Mich. One complete revolution of the center-pin increases the diameter across the cutters 0.025 inch. The center-pin is hardened and ground to insure an accurate adjustment. It supports the cutters in a direct line with the thrust of the cut.



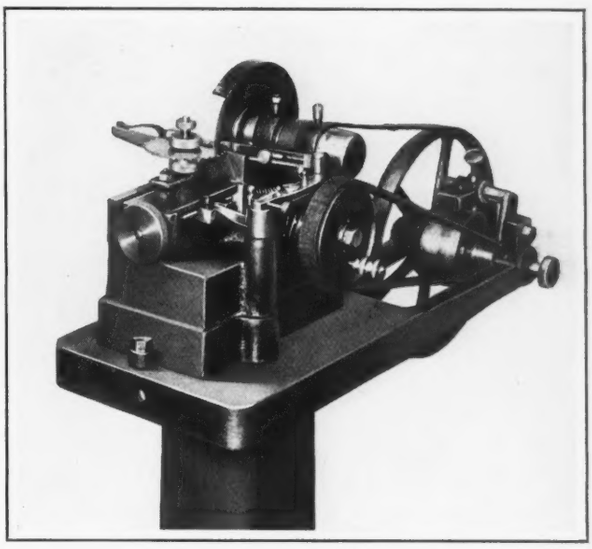
Adjustable Boring Head placed on the Market by the Madison Mfg. Co.

This boring head is designed for use in high-powered machines where rapid production is desired, and as it is provided with six blades, a heavy feed can be employed. High-speed steel blades are generally furnished, but stellite blades may also be supplied. The head is made with any form of shank, and from 2½ to 8 inches in diameter across cutters. The pilot-bar shown is used when boring deep holes.

SCHERR AUTOMATIC SAW SHARPENER

The sharpening of small metal-cutting saws, screw-slotters, etc., 8 inches and less in diameter, may be conveniently accomplished by means of a No. 2 automatic saw sharpener now being introduced to the trade by George Scherr, 126 Liberty St., New York City. Accuracy is assured by an indexing arrangement which, through the intermittent movement of a finger, brings the teeth of the saw successively in alignment with the grinding wheel. This finger is of such design that it functions, even though a tooth may be broken out. The saw is mounted on a slide which is reciprocated to and from the wheel after each indexing. The movement of this slide is set for each job by means of a knurled-head adjusting screw on the slide.

After the saw has been mounted in place and the necessary adjustments have been made, power is transmitted to the feeding and indexing mechanisms through a clutch on the driving shaft. From then on, the operation is automatic until the sharpening of the saw has been completed. The grinding wheel revolves continuously, regardless of whether the clutch is in or out of mesh. The wheel is dressed to suit the shape of the saw teeth. This machine handles saws from 1½ to 8 inches in diameter and up to about 5/32 inch in



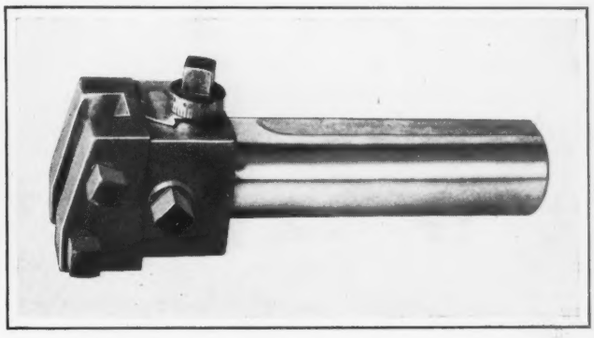
Sharpening Machine for Small Saws, placed on the Market by George Scherr

thickness, with a distance from tooth to tooth, measured along the periphery of the saw, up to ⅜ inch. The weight of the machine on a 30-inch column is about 135 pounds.

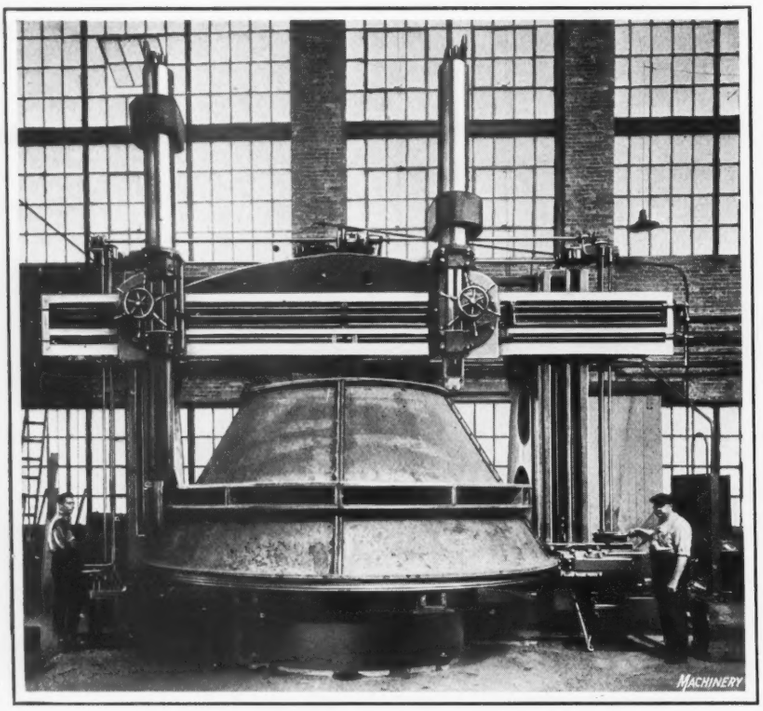
A No. 1 machine of the same general design but of a smaller size is also built, while a No. 3 machine provides for the automatic sharpening of circular and band metal- and wood-cutting saws and milling cutters up to 3/16 inch thick.

WARNER & SWASEY ADJUSTABLE CUTTER-HOLDER

In turning work to accurate size on a turret lathe through the use of a cutter-head, at least two cuts must be taken over the surface being machined. The roughing cut can be held to a limit of about 0.004 inch, when using a common holder, by tapping the cutter lightly with a hammer. Considerable skill, however, is required in taking the finishing cut by the same method, to prevent moving the cutter too far and spoiling the work. An adjustable cutter-holder designed by the Warner & Swasey Co., Cleveland, Ohio, which is here illustrated, eliminates guesswork in adjusting the



Adjustable Cutter-holder made by the Warner & Swasey Co.



Large Boring and Turning Mill built by the Betts Machine Co.

cutter to close limits. The cutter is held at an angle and adjusted by turning the graduated screw which operates the cutter-slide.

The head is made of hardened steel throughout. In using the tool, the locking screw is drawn up tightly and kept in that position. An adjustment can then be made without changing the tension of the screw. An adjustment as small as 0.0005 inch is possible. In addition to the advantage of obtaining the original setting easily, the cutter can be adjusted to cut the work to the desired size when the cutting edges become worn.

BROWN & SHARPE MICROMETER CALIPER

To meet the needs of automobile repair shops for a micrometer caliper having a sufficient range to permit the measurement of both the small-size pistons now supplied on certain automobiles and the large-size pistons used in trucks and tractors, the Brown & Sharpe Mfg. Co., Providence, R. I., has changed the range of the No. 55 micrometer caliper which it manufactures. This caliper will now take measurements from 2 to 6 inches, the range being secured through the use of four anvils. The anvils are held in position by a knurled nut, which enables them to be changed rapidly. The general construction of this tool is similar to other Brown & Sharpe micrometer calipers.

BETTS BORING AND TURNING MILL

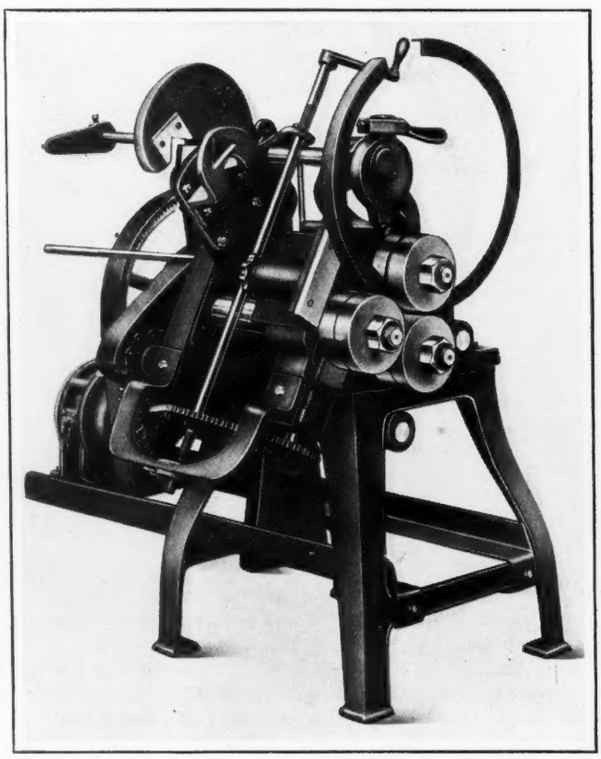
A large boring and turning mill with a capacity for work up to 16 feet 4 inches swing and 8 feet 4 inches height is here illustrated. This machine, which is built by the Betts Machine Co., 400 Blossom Road, Rochester, N. Y., has a number of interesting features. The two tool-heads are equipped with tool-steel spindles of extra long travel, and have a ring-type, self-contained, counterbalancing arrangement. The tool-spindle at the right is provided with a special attachment for turning tapers at any angle from 0 to 90 degrees. The right-hand upright carries a sliding side-head which has both horizontal and vertical power-feeds to the tool-slide. A power rapid traverse is provided for the three heads for each direction in which they may be operated.

This machine is driven by a constant-speed motor through a friction clutch. A brake allows the machine to be stopped instantly without stopping the motor. All speed changes are obtained by means of sliding, hardened steel gears running in a bath of oil. This machine is used principally for turning large castings such as are shown on the table in the illustration.

EXCELSIOR ANGLE-IRON BENDING MACHINE

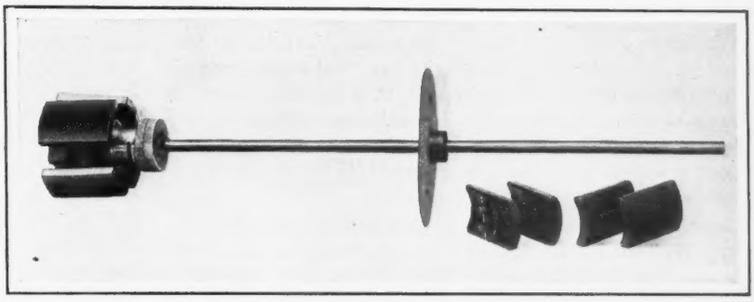
A machine that will cut to length and bend in a circle angle-iron up to 2 by 2 by ¼ inch has been brought out by the Excelsior Tool & Machine Co., 30th St. and Ridge Ave., East St. Louis, Ill. The machine will also handle bar stock up to 4 by ½ inch and 2-inch T-iron, with the same bending rolls, these being adjustable to meet requirements. Special rolls may also be furnished to suit the bending of pipe channel-iron, or other shapes. The machine has three roll shafts, on each of which are two rolls which may be separated by steel washers of a thickness to suit the angle-iron being bent. Each roll has one straight and one rounded edge. To roll work so that the edge of a leg will be on the outside, the upper rolls should have the square edges together without spacers between them and the lower rolls should have the rounded edges together with spacers between them to allow one leg of the angle-iron to extend between the rolls. Guides are used to insure that the work will be rolled free from twists. With work rolled in this way two pieces may be handled at one time.

To roll work with the edge of one leg toward the inside of the circle, as shown in the illustration, the lower rolls should have the square edges together while the upper rolls should have the rounded edges together with spacers between them. Work of this type must be rolled one piece at a time. The



Machine for bending Angle-iron in Circles, which is a Product of the Excelsior Tool & Machine Co.

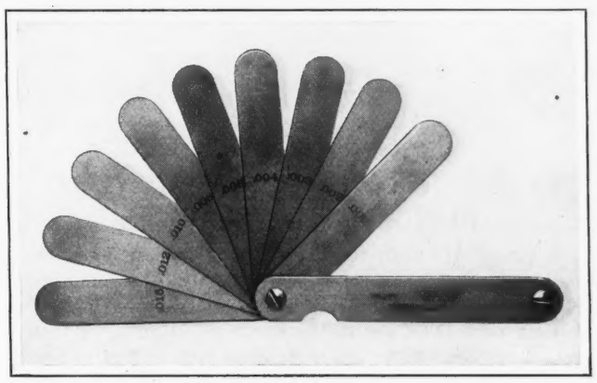
guides previously referred to are also used for this work. The upper-roll shaft has a 2½-inch movement obtained through eccentrics. This shaft is set with an allowance not exceeding the thickness of the angle-iron leg which extends between the upper and lower rolls. When duplicating work of the same thickness, a set-screw adjustment is used to clamp the eccentric so as to hold the rolls together. The machine is operated through a patented friction clutch and both belt- and motor-driven machines can be started and stopped under pressure. The speed of the rolls is fifteen revolutions or twenty-five lineal feet per minute.



Internal Lapping Tool brought out by the Stimson Engineering Co.

LUFKIN IMPROVED THICKNESS GAGES

The principal feature of a line of improved thickness gages or feelers being placed on the market by the Lufkin Rule Co., Saginaw, Mich., is a patented lock by means of which any leaf may be held firmly in a set position. This feature will appeal particularly to automobile mechanics and repair men. For example, in making adjustments of tappets on engines, the holding of a leaf by means of the lock-nut



No. 109 Thickness Gage with Patented Lock, which is made by the Lufkin Rule Co.

permits of using the entire length of the leaf. On V-type motors, where work is performed at an angle, the gages are particularly useful.

Each leaf is 3 inches long and ½ inch wide. The No. 06 gage has six leaves ranging in thickness from 0.002 to 0.015 inch; the No. 07, seven leaves ranging from 0.0015 to 0.015 inch; and the No. 09, nine leaves ranging from 0.0015 to 0.015 inch. The thickness of each leaf is clearly marked on one side. On these three gages the thickest leaf and a nameplate serve as a case to protect the other leaves. The No. 109 gage, which is here illustrated, has the same leaves as the No. 09 gage, but is provided with a case into which all the leaves fold.

STIMSON INTERNAL LAPPING TOOL

An internal lapping tool developed particularly for lapping automobile cylinders but which can be furnished in any special size to meet machine shop requirements, has been placed on the market by the Stimson Engineering Co., 598 Sixty-eighth Ave., Milwaukee, Wis. The tool consists of a shaft, at one end of which lapping shoes are mounted. Two sets of shoes are regularly furnished, one of which may be adjusted to from 2¾ to 3½ inches in diameter, and the other to from 3½ to 4¼ inches in diameter. These shoes are held in place by cotter-pins and may be quickly substituted for each other. They are adjustable to the proper diameter by simply turning a tapered nut which is firmly held in position after an adjustment by means of a lock-nut. A disk placed loosely on the shaft rests on top of the casting being lapped. A collar is employed to regulate the maximum distance between the disk and the lapping shoes, thus controlling the depth to which the tool is fed into the work. This lapping tool may be driven by an electric or air drill or by connection to a machine spindle through the use of a flexible coupling. A patent has been applied for on this device.

BLOUNT HEAVY-DUTY GRINDING MACHINE

A 5-horsepower heavy-duty motor-driven grinding machine equipped with an alternating-current motor and either 18- by 3- by 1½-inch or 16 by 3 by 1½-inch grinding wheels, is a recent addition to the line of machine tool equipment built by the J. G. Blount Co., Everett, Mass. The machine is equipped with S K F ball bearings throughout. The motor end shields are iron castings on which a recess is turned, and they are bolted directly to the motor frame. The shields are further secured in position by supports clamped around their hubs and bolted to each side of the head casting. The shield flanges are screwed into the shields. These flanges are machined all over and recessed on the inside. Either plain or exhaust type adjustable wheel guards may be furnished, as desired.

A Westinghouse safety starting switch is mounted within the column on a separate panel, which is easily removed from the rear of the machine without disconnecting the switch. This switch protects the operator and equipment against accidental starting of the motor. The switch cannot be held closed on an overload. The machine weighs 1200 pounds.

Five-horsepower Heavy-duty Grinding Machine brought out by the J. G. Blount Co.

NEW MACHINERY AND TOOLS NOTES

Tool-holder: Lovejoy Tool Works, 331 W. Ohio St., Chicago, Ill. A tool-holder, known as the "Use-em-up," which is intended to effect savings by making it possible to use up short tool bits. It will hold full-length tool bits, but is particularly useful when the tool bits become short through repeated grinding, tool bits as short as 11/16 inch being rigidly held.

Combination Punching and Shearing Machine: Amplex, Inc., 6 W. 32nd St., New York City. A punching and shearing machine having a solid steel frame. The operator's side of the machine is clear of all such encumbrances as flywheels and driving gears. A slanting centering slide allows for making mitering cuts without lifting the work. The machine is arranged for punching both the webs and flanges of structural shapes, and the throat is designed to accommodate broad-flanged Bethlehem shapes. The punch has a lowering device for locating center marks before punching.

Engine Lathes: Carroll & Jamieson Tool Co., 257 Davis St., Batavia, Ohio. A line of lathes designed primarily for tool-rooms and automobile service stations. The 14- and 16-inch machines are of the quick-change type and can be supplied with either single or double back-gears. A semi-quick-change lathe with a single back-gear can be supplied in the 13-inch size. The quick-change gear mechanism provides for cutting all standard and odd threads from 3 to 64 per inch, either right- or left-hand. On the semi-quick-change lathe, three changes of feed are obtainable by shifting a lever, and additional changes may be secured through the use of change-gears.

Elevating Platform Truck: Clark Tructractor Co., Buchanan, Mich. A gasoline-driven elevated truck having a loading platform 26 inches wide by 54 inches long. This truck will elevate a load of 4000 pounds from a minimum height of 11 inches to a maximum height of 16 inches, in eight seconds. Automatic stops control both the upper and lower limits of travel, and the load can be stopped at any point. The lifting mechanism is operated by hydraulic pressure. Power both for driving the truck and elevating the load is obtained from a 15-horsepower, four-cylinder tractor engine. The driving and elevating controls are at the rear of the engine compartment where the operator rides in a standing position.

Crane Magnet Cable Retriever: Pawling & Harnischfeger Co., 38th and National Aves., Milwaukee, Wis. A feeder cable retriever that differs from the ordinary types of cable take-up drums which have positive geared or chain sprocket drives. This retriever is designed to keep the cable taut at all times, a fixed but moderate tension being maintained on the cable. The cable winds up and pays out without slack or undue strains. The drum is driven only in the hoisting direction, the gearing being proportioned to drive the drum at a greater peripheral speed than that at which the magnet is being hoisted. This arrangement causes the friction drive to slip and produces a tension on the cable which may be adjusted by tightening a thrust spring in the friction drive.

* * *

EXAMINATIONS FOR PATENT AND TRADEMARK EXAMINERS

Examinations to fill vacancies in positions of assistant examiner in the Patent Office will be held by the Civil Service Commission on May 10, 11, and 12 and on June 21, 22, and 23 throughout the United States. The entrance salary for these positions is $1500 a year plus a bonus of $20 a month, and there is provision for promotion to positions paying from $1650 to $3900 a year. Technical training is necessary. Announcement is also made of an open competitive examination for assistant examiner of trademarks, to be held on May 24. The salaries for this work range from $1500 to $2050 a year. Full information and application blanks may be secured from the United States Civil Service Commission, Washington, D. C., or the Civil Service Board in any city.

GERMAN MACHINE TOOL EXPORTS

Figures received from Germany by the Department of Commerce indicate that there was a considerable decrease in the volume of Germany's machine tool exports during 1921, as compared with 1920 and the pre-war year of 1913. Germany's custom-house returns show that the total machine tool exports for the seven months from May to November, 1921, were 39,046 metric tons. Of these exports 7547 metric tons went to Belgium, and 5087 to France. The Netherlands received 4559 metric tons and Italy 3466, while Austria received 2823. Other countries receiving over 1500 metric tons were Czecho-slovakia, Switzerland, and South America. Countries receiving over 1000 metric tons were Great Britain and Spain, while those receiving over 350 but less than 800 metric tons, were Denmark, Alsace-Lorraine, Norway, and Sweden. Other countries not mentioned in the report received a total of 6000 metric tons. In comparing these figures it should be borne in mind that the German classification of machine tools is an extremely broad one, and includes metal-working, woodworking and stone-working machinery, as well as hydraulic presses, riveting machines and power hammers.

A recent Commerce Report shows that Germany's total machine tool exports during the year 1920 were 94,921 metric tons. During 1920 the Netherlands took over 19,000 metric tons of Germany's machine tool exports and France 13,668, while Switzerland ranked next in importance, taking 11,760 metric tons. Belgium and Italy each took approximately 7500 metric tons; Sweden 5433; Austria 4978; Czecho-slovakia 3360; Spain 3268; Denmark 2806; and South America 2949 metric tons.

* * *

RELATION OF UNEMPLOYMENT TO BUSINESS DEPRESSIONS

The President's Conference on Unemployment, held under the chairmanship of Secretary Hoover last fall, recommended that a serious attempt be made to analyze the causes of alternate periods of expansion and depression in industry, reflected in the so-called business cycle, and to find remedies for practical use in business. Acting upon this recommendation, Secretary Hoover appointed a committee which is undertaking a survey through the National Bureau of Economic Research, of which Dr. Wesley C. Mitchell is director.

At the first meeting of the director and the committee, preliminary surveys of the sources of information for such a study, by committees representing the Editorial Conference of Business Paper Editors and the Federated American Engineering Societies, were requested. A second meeting of the committee was held on April 13, at the Department of Commerce, at which the various sub-committees made reports before the general committee and a representative group of trade association secretaries and editors of leading engineering and trade journals. The general committee especially requested cooperation in securing definite suggestions as to members of trade associations who had evolved plans of minimizing the waste of the business cycle.

The report of the general committee will be divided into three parts: (1) a diagnosis of unemployment; (2) relation of unemployment to business cycles; and (3) the proposed measures and preventives of cyclical unemployment. The committee especially asks the industries for suggestions so as to make the third part of the report as practical as possible. Preliminary surveys indicate that constructive measures may be found in long-range planning of construction work, in various plans for stabilizing production, and in the use of statistical indexes of business conditions to meet periods of depression.

Anyone who has had experience along these lines is requested to forward this information to E. E. Hunt, secretary of the committee, Bureau of Foreign and Domestic Commerce, Chamber of Commerce, Washington, D. C.

HARDENING HIGH-SPEED STEEL CUTTERS

By JAMES CRAN

On page 481 of February MACHINERY there appears a note under the heading "Hardening High-speed Cutters." It is the writer's opinion that the procedure here outlined represents rather a short-cut method and that better cutters of high-speed steel would be obtained by the process described in the following. Any small standard furnace, whether oil, gas, or electrically heated, provided it is of the muffle or semi-muffle type and capable of being heated to about 2300 degrees F., answers the purpose. For the best results it is advisable to use three furnaces, but two are more generally used, and good work can be done with only two furnaces.

Method of Hardening when Using Two Furnaces

When two furnaces are used, the cutters to be hardened should be heated in one of them to 1600 or 1650 degrees F. and then transferred to the other furnace registering about 2300 degrees F. While 2300 degrees F. is rather a high temperature for high-speed steel, 2250 degrees F. is considered ideal. As soon as a cutter which has been preheated to about 1600 degrees F. is placed in a furnace registering 2300 degrees F., the temperature of the furnace will drop while the temperature of the cutter rises, and the result is that by the time the cutter has reached the desired temperature of 2250 degrees F. the heat of the furnace will have dropped 50 degrees.

On removing the cutter from the furnace, it should be immediately immersed in oil, which may be fish, linseed, cottonseed, rape, or any of the standard quenching oils in general use. The cutter should be kept moving slowly in the quenching bath until it has reached a black heat, which will be indicated by the cessation of smoke bubbles; it may then be allowed to cool down to the point where it can be handled without gloves. While movement of the cutter in the quenching oil is necessary to facilitate carrying off the heat, this should be done carefully, for if the cutter is moved too fast a vacuum will be formed behind it with the result that only one side of the cutter will actually be in contact with the oil.

Method of Hardening when Using Three Furnaces

When conditions will permit of three furnaces being used, more and better hardening can be done. It is best to have one furnace heated to a temperature of about 1300 degrees F. in which the cutters are preheated slowly and thoroughly until they have reached the temperature of the furnace. They should then be transferred to another furnace having a heat of about 1800 degrees F. and then to one of about 2300 degrees F. The rest of the procedure is the same as stated previously.

Final Heat-treatment

To give the maximum service, all high-speed steel cutters should be subjected to a second or tempering heat of about 1050 degrees F. This second heat makes the cutters much harder and tougher than they are when they come from the quenching bath. In quenching cutters of high-speed steel, it is advisable to leave some of the initial heat in them until they can be heated the second time or tempered, as this will tend to prevent cracking. High-speed steel is harder after being subjected to a second heat than it is when it comes from the quenching bath, because of the alloys it contains and their action in quenching.

It is well known that all steels, when they are in solution (which is the right condition for quenching) are austenitic, or have a grain structure the same as any pure metal. While straight carbon steel and some alloy steels are austenitic at the quenching temperature, the austenite changes to martensite in cooling, and in consequence, if the heating and other conditions are right, the steel will be in the hardest possible condition when quenched.

High-speed steel usually contains from 3½ per cent to 4 per cent chromium and about 18 per cent tungsten. Both of these alloys deter its passing into and coming out of solution; thus it is necessary to heat high-speed steel to a higher temperature than straight carbon steel, to get the various alloys of which it is composed saturated with the iron or ferrite, which comprises the major part of the steel. But it is also possible to make high-speed steel pass into solution at a much lower temperature than 2250 degrees F. by allowing it to soak for a time at 2000 degrees F. or even less. When this is done, however, it is likely to have a very much overheated structure, and in consequence will not stand up like a tool that has been brought quickly to the proper heat.

By watching a high-speed steel cutter closely when it is nearing the critical point, it will be noticed that it begins to have a greasy or sweaty appearance and small bubbles appear which work through each other; this is the ideal condition for quenching. If it is left longer in the furnace, the bubbles will change to blisters, which is a sure sign of overheating. In quenching high-speed steel, the chromium and tungsten tend to keep it in the austenitic condition, making a second heat necessary to bring it to martensite.

Effect of Second Heat on High-speed Steel Cutters

A good example of what a second heat on high-speed tools will do can be had by watching a lathe or planer tool which has been put to work directly after being quenched and ground and then noting the difference in the quality of the tool after a second grinding. After the second grinding it will stand up better than it did at first on account of the heat generated in removing the chip, which changes the structure from austenite to martensite on the extreme end or cutting edge.

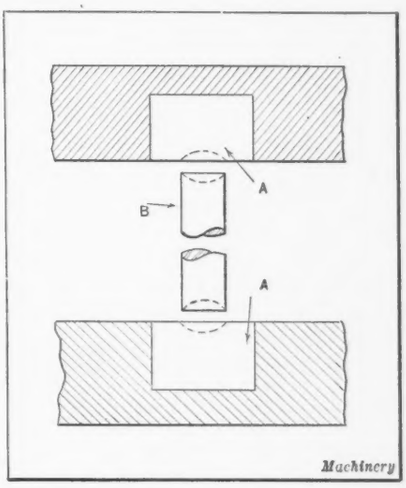
The temperatures here given are intended only as a basis to work from, and it is necessary for the hardener to use judgment according to the size of the pieces to be hardened. Very small tools can be hardened perfectly in a furnace having a temperature as low as 2250 degrees F., because they are not likely to bring the heat of the furnace down very much, but with heavy cutters it may be well to have the temperature of the furnace slightly higher than any of the temperatures here given so as to bring the work to the desired heat without danger of oversoaking it and thereby impairing the structure.

* * *

COLD RIVETS FOR ELECTRICAL APPARATUS

By JOHN E. UNGER

Several types of cold rivets and heading buttons used in making electrical apparatus were described by the writer in an article appearing in March MACHINERY, page 569. In the accompanying illustration is shown another type of button *A* which is being used in a certain plant for upsetting the ends of rivets of the type shown at *B*. It will be seen that the ends of the rivet, as well as the ends of the buttons are concave. In the writer's opinion, this represents poor practice as the heading operation will swell the rivet from end to end without forming a satisfactory head. The upsetting buttons shown were being used in a hydraulic press.



Example of Rivet-heading Buttons of Poor Design

EXPORTS OF MACHINE TOOLS AND METAL-WORKING MACHINERY FOR 1921

Country*	Lathes	Sharpening and Grinding Machines	Other Machine Tools	Total of Machine Tools	All Other Metal-working Machinery	Total of Machine Tools and Other Metal-working Machinery	Comparison with 1920 Exports		
							Machine Tools	Other Metal-working Machinery	Total of Mch Tools and Other Metal-working Machinery
Europe:									
Azores and Madeira Is.	.....	$2,328	$481	$2,809	$4,063	$6,872	$6,077	$2,604	$8,681
Belgium	$236,996	37,652	125,003	399,651	262,476	662,127	1,195,942	724,230	1,920,172
Bulgaria	.....	.....	1,409	1,409	200	1,609	14,071	.....	14,071
Denmark	3,040	2,474	21,013	26,527	5,244	31,771	167,782	66,709	234,491
Finland	4,539	1,486	4,243	10,268	10,372	20,640	40,683	22,423	63,106
France	556,265	127,140	715,879	1,399,284	2,645,077	4,044,361	3,839,113	3,756,620	7,595,733
Germany	116	13,352	33,819	47,287	71,222	118,509	73,630	70,562	144,192
Greece	10,470	625	30,717	41,812	8,742	50,554	32,620	22,752	55,372
Iceland and Faroe Is.	950	.....	.....	950	.....	950	1,702	.....	1,702
Italy	2,972	11,575	65,151	79,698	159,572	239,270	899,740	589,078	1,488,818
Jugoslavia, Albania, etc.	.....	124	.....	124	.....	124	.....	.....	.....
Netherlands	35,544	8,594	69,455	113,593	40,368	153,961	273,967	87,057	361,024
Norway	2,614	3,436	17,743	23,793	5,659	29,452	112,794	45,406	158,200
Poland and Danzig	29,474	1,366	35,340	66,180	42,101	108,281	28,327	10,349	38,676
Portugal	921	636	6,521	8,078	5,942	14,020	47,758	16,328	64,086
Rumania	106,643	5,640	24,629	136,912	107,462	244,374	67,597	37,244	104,841
Russia in Europe	400	.....	754	1,154	25	1,179	88,444	89,826	178,270
Spain	72,389	48,894	120,322	241,605	127,426	369,031	781,306	363,538	1,144,844
Sweden	12,853	6,993	42,193	62,039	47,767	109,806	316,485	130,302	446,787
Switzerland	2,091	738	3,484	6,313	12,576	18,889	202,543	55,392	257,935
Turkey in Europe	7,123	616	1,361	9,100	1,295	10,395	29,787	2,750	32,537
United Kingdom:									
England	134,630	165,472	703,305	1,003,407	1,541,986	2,545,393	6,096,086	4,664,871	10,760,957
Scotland	.....	12,025	51,662	63,687	89,241	152,928	154,950	83,190	238,140
Ireland	516	2,562	2,261	5,339	56,858	62,197	25,482	110,988	136,470
North America:									
Bermuda	2,157	70	840	3,067	25	3,092	2,386	.....	2,386
British Honduras	.....	291	.....	291	180	471	66	41	101
Canada	94,369	148,343	399,764	642,476	575,536	1,218,012	3,298,542	2,516,772	5,815,314
Central American States:									
Costa Rica	64	1,145	2,511	3,720	3,665	7,385	18,058	999	19,057
Guatemala	4,100	164	1,432	5,696	8,230	13,926	8,998	925	9,923
Honduras	14,346	1,239	9,303	24,888	2,653	27,541	19,199	11,299	30,498
Nicaragua	23,624	68	1,471	25,163	380	25,543	4,226	1,811	6,037
Panama	25,841	2,967	14,274	43,082	18,920	62,002	30,143	41,657	71,800
Salvador	1,734	445	1,605	3,784	1,724	5,508	3,522	272	3,794
Mexico	170,186	43,068	251,737	464,991	283,903	748,894	345,056	265,516	610,572
Miquelon, Langley, etc.	19	.....	.....	19	.....	19	1,105	.....	1,105
Newf'land and Labrador	60	91	2,348	2,499	5,380	7,879	10,646	3,100	13,746
West Indies:									
Barbados	498	.....	256	754	421	1,175	689	99	788
Jamaica	3,778	267	1,371	5,416	955	6,371	13,871	10,703	24,574
Trinidad and Tobago	15,843	927	11,264	28,034	28,566	56,600	38,663	11,981	50,644
Other British Possessions	750	89	140	979	763	1,742	2,840	413	3,253
Cuba	209,870	23,879	150,919	384,668	191,015	575,683	941,883	276,986	1,218,869
Dominican Republic	30,439	195	6,923	37,557	17,375	54,932	31,087	18,016	49,103
Dutch West Indies	4,797	1,865	836	7,498	7,649	15,147	1,124	173	1,297
French West Indies	.....	12	610	622	4,257	4,879	2,040	1,428	3,468
Haiti	118	110	924	1,152	240	1,392	4,481	.....	4,481
Virgin Is. of U. S.	2,265	20	1,553	3,838	65	3,903	3,565	1,445	5,010
South America:									
Argentina	69,337	33,197	111,034	213,568	137,585	351,153	385,423	165,984	551,407
Bolivia	2,460	1,005	2,167	5,632	501	6,133	8,514	6,317	14,831
Brazil	246,106	70,084	165,568	481,758	244,470	726,228	306,282	148,902	455,184
Chile	46,826	16,548	59,192	122,566	132,202	254,768	129,018	314,361	443,379
Colombia	24,237	6,813	12,491	43,541	64,368	107,909	87,653	24,390	112,043
Ecuador	11,959	1,941	9,185	23,085	2,096	25,181	16,319	2,417	18,736
Guiana:									
British	.....	122	96	218	113	331	5,094	1,368	6,462
Dutch	1,207	.....	2,333	3,540	15,489	19,029	1,266	780	2,046
French	4,316	305	8,183	12,804	69	12,873	9,955	.....	9,955
Peru	28,175	10,710	82,952	121,837	68,776	190,613	133,102	89,727	222,829
Uruguay	3,680	1,521	12,665	17,866	2,032	19,898	42,207	11,626	53,833
Venezuela	11,451	2,889	16,720	31,060	19,553	50,613	28,848	22,027	50,875
Asia:									
China	121,253	23,766	38,254	183,273	188,111	371,384	709,789	222,562	932,351
Kwangtung, Leased Territory	.....	5,192	868	6,060	1,398	7,458	1,995	8,626	10,621
Chosen	.....	3,869	127	3,996	451	4,447	7,723	4,680	12,403
East Indies:									
British India	84,975	33,059	307,780	425,814	996,370	1,422,184	719,778	654,290	1,374,068
Straits Settlements	1,649	2,691	16,306	20,646	7,148	27,794	48,929	4,491	53,420
Other British Possessions	.....	.....	1,310	1,310	.....	1,310	6,280	10	6,290
Dutch	76,512	17,165	104,660	198,337	163,059	361,396	194,589	131,497	326,086
French Indo-China	.....	.....	276	276	200	476	2,777	205	2,982
Hejaz, Arabia, Mesopotamia	.....	128	.....	128	.....	128	.....	.....	.....
Hongkong	6,948	866	57,556	65,370	46,081	111,451	82,858	114,480	197,338
Japan	301,028	198,236	430,462	929,726	1,706,292	2,636,018	1,954,242	2,296,341	4,250,583
Palestine and Syria	49	.....	352	401	.....	401	.....	.....	.....
Persia	.....	.....	2,070	2,070	2,355	4,425	.....	.....	.....
Siam	336	1,772	1,781	3,889	3,301	7,190	1,771	729	2,500
Turkey in Asia	2,737	.....	100	2,837	25	2,862	5,457	.....	5,457
Oceania:									
Australia	83,410	68,884	167,284	319,578	171,399	490,977	667,094	218,396	885,490
New Zealand	19,571	29,334	37,995	86,900	32,795	119,695	164,155	34,106	198,261
Other British Possessions	.....	1,672	197	1,869	.....	1,869	55	12	67
French	.....	.....	477	477	724	1,201	820	4,060	4,880
Other Oceania	918	.....	.....	918	22	940	.....	1,283	1,283
Philippines	29,880	15,728	39,323	84,931	101,727	186,658	164,782	86,649	251,431
Africa:									
Belgian Kongo	80	34	63	177	1,426	1,603	5,404	1,818	7,222
British Africa									
East	.....	6,464	596	7,060	.....	7,060	6,745	180	6,925
South	49,570	12,453	109,492	171,515	141,310	312,825	223,175	113,007	336,182
West	.....	141	579	720	714	1,434	4,584	3,475	8,059
Canary Islands	.....	.....	.....	.....	328	328	1,079	.....	1,079
Egypt	56	334	9,477	9,867	4,552	14,419	27,519	3,893	31,412
French Africa	.....	559	574	1,133	1,124	2,257	5,767	3,982	9,749
Madagascar	.....	.....	17	17	.....	17	1,025	1,025	2,050
Morocco	578	292	196	1,066	.....	1,066	3,073	2,264	5,337
Portuguese Africa	33,097	837	27,032	60,966	13,173	74,139	15,080	7,212	22,292
Total:†	2,997,689	1,217,280	4,774,294	8,989,263	10,668,558	19,657,821	25,481,856	18,830,377	44,312,233

*There were no machine tools or metal-working machinery exported in 1921 to countries not listed.
†The 1920 totals include exports to a few of the smaller countries not listed in the table.

PERSONALS

P. R. HOOPES, formerly associated with the Automatic Machinery & Equipment Co., Philadelphia, Pa., is now connected with Lorenz & Lorenz, Hartford, Conn., as mechanical engineer.

W. C. AMES has been appointed district sales manager of the Sharon Pressed Steel Co. at 20 E. Jackson Blvd., Chicago, Ill., and RALPH E. PHILLIPS has been appointed district sales manager at 66 Broadway, New York City.

W. H. MILLER has been appointed supervisor of tools and gages of the inspection and testing department of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa., and W. F. ABLAUF has been appointed supervisor of mica and mica processes.

LESLIE H. TAYLOR, formerly sales manager of the machine tool division of the Greenfield Tap & Die Corporation, Greenfield, Mass., has become sales manager of the Williams Tool Corporation, Erie, Pa., manufacturer of pipe and bolt threading machinery.

FRED MATHEWS, formerly vice-president of the Union Metal Products Co., has become general railway sales representative of the A. O. Smith Corporation, Milwaukee, Wis., manufacturer of pressed steel products. Mr. Mathews' offices are at 1306 Consumers Bldg., Chicago, Ill.

W. L. GARCIA has become associated with the Fairbanks Co., 416 Broome St., New York City, in the engineering and power transmission department. He has had twenty-five years experience as a transmission engineer. The Fairbanks Co. is sales agent for the Lewellen variable-speed transmission.

R. P. RAYMOND, formerly chief draftsman for the Columbia Graphophone Co., Bridgeport, Conn., has been appointed superintendent of manufacture for the Columbia Graphophone Co., Ltd., of Toronto, Canada, and will have charge of the manufacture of complete grafonolas, including the cabinets, motors, and records.

H. A. EATON, Indianapolis and Cincinnati representative of the Precision Grinding Wheel Co., Inc., Philadelphia, Pa., has been transferred to the Boston territory and will make his headquarters at the Davis Hardware Co. of Boston. J. O. Smith, previously at Boston, has been transferred to Mr. Eaton's former territory.

H. L. JONES, formerly assistant superintendent of the switchboard and detail department of the Westinghouse Electric and Mfg. Co., East Pittsburg, Pa., has been appointed superintendent of that department. A. J. BASTIAN, formerly assistant superintendent of the insulating department, has been made superintendent of that department.

W. C. PETERSON, formerly metallurgical engineer for the Atlas Crucible Steel Co., has been made manager of the alloy steel division of the Electric Alloy Steel Co., Youngstown, Ohio. Prior to his association with the Atlas Crucible Steel Co., Mr. Peterson was connected for twelve years with the Packard Motor Car Co., having charge of the metallurgical laboratories and heat-treating departments.

GEORGE K. ATKINSON was elected president and general manager of the Langhaar Ball Bearing Co., Aurora, Ind., at a recent meeting of the board of directors. Mr. Atkinson was formerly connected with the Modern Machine Tool Co. of Cincinnati, and recently was eastern sales manager for the Manufacturers' Equipment Co. of Chicago. L. Langhaar was elected vice-president and will also act as sales manager.

F. G. DAVIS, for three years representative of the Atlas Crucible Steel Co. in the Detroit district has become district manager of sales in Detroit for the Electric Alloy Steel Co., Youngstown, Ohio. Mr. Davis will occupy a temporary office in Room 1716, Ford Bldg. The company is installing a complete warehouse stock in Detroit, and the district offices will be moved to the new warehouse as soon as arrangements are completed.

HARRISON P. REED, for many years electrical engineer and more recently head of the elevator department of the Cutler-Hammer Mfg. Co., of Milwaukee and New York, has been appointed general manager of the A. Kieckhefer Elevator Co., Milwaukee, Wis. Mr. Reed is a graduate of the Electrical Engineering Department of Cornell University, and is a member of the American Institute of Electrical Engineers and the Engineers' Society of Milwaukee.

EDWARD BLAKE, JR., vice-president of the Greenfield Tap & Die Corporation, Greenfield, Mass., who has been general manager of the company's drill plant at Taunton, has been appointed vice-president in charge of sales and will make his headquarters in Greenfield. Mr. Blake was connected with the Wells Bros. Co. for several years, and eleven years ago became vice-president and general manager of the Lincoln Twist Drill Co. at Taunton, which was sold in July, 1920, to the Greenfield Tap & Die Corporation.

WILLIAM OCHSE, for the last two years sales representative of Manning, Maxwell & Moore, Inc., at Chicago, has become efficiency engineer of the Ohio Machine Tool Co., Kenton, Ohio, manufacturer of shapers and planers. Before joining the sales organization of Manning, Maxwell & Moore, Mr. Ochse was connected for twenty years with Gould & Eberhardt, Newark, N. J., manufacturers of shapers and automatic gear and rack cutting machinery, latterly having charge of their planning and tool design department.

WILLIAM L. COLT, for nearly five years division manager of Willys-Overland Inc., in the eastern district, with headquarters in New York, has resigned to become president of the Overland Providence Co. CARL P. SPIEGELBERG, who organized the Overland Providence Co. under the supervision of Mr. Colt, will continue to operate the business as vice-president and general manager. Mr. Colt is well-known in the automobile business. Prior to his association with Willys-Overland, Inc., he was president, for eight years, of the Colt-Stratton Co., distributor of Dodge automobiles in the New York district.

G. F. SHERRATT has been appointed manager of the Pittsburg office of the Chain Belt Co., Milwaukee, Wis., which is located in the Union Arcade Bldg. Mr. Sherratt will have charge of all the company's chain and engineering business in the Pittsburg territory, and will render engineering service on power transmitting and material handling problems. The Pittsburg office will handle a complete line of "Rex" chain and material-handling equipment. The Ward Equipment Co., of Pittsburg, will continue to handle the complete line of "Rex" concrete mixers and pavers, and the United Equipment Co. will handle "Rex" traveling water screens.

C. E. SKINNER, manager of the research department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed assistant director of engineering of the company. His duties will cover research standards and other work along these lines, and he will be located in the main offices of the company. Mr. Skinner is known throughout the electric world for his extensive research work, especially on insulation, and his efforts in that direction have had a marked effect on the development of electrical machine design. S. M. KINTNER, who is well known for his research and engineering work in the development of radio apparatus, will succeed Mr. Skinner as manager of the research department.

RALPH BARSTOW, general sales manager of the Greenfield Tap & Die Corporation, Greenfield, Mass., has resigned to go into business for himself as merchandising counselor, in association with Marquis Regan, Inc., at 21 E. 40th St., New York City. The business is not that of advertising, but has to do with sales direction and plans for selling merchandise. Mr. Barstow went to Greenfield in July, 1919, after nine months' service as director of the department of selling and advertising in the American Expeditionary Forces University at Beaune, France. For two years he has been an instructor in sales methods for the State University Extension, which previously adopted a course in sales and advertising of which he is the author.

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OBITUARIES

EDWARD P. MAGUIRE, general manager of the Lapointe Machine Tool Co., Hudson, Mass., died March 28 in St. Vincent's Hospital in Hudson. Mr. Maguire was born in Sharon, Mass., in 1889. He came to Hudson about fifteen years ago and entered the employ of the Lapointe Machine Tool Co. as bookkeeper. When the company was reorganized in 1914 he was made general manager of the plant, and held that position until the time of his death. He is survived by his wife and two children. Mr. Maguire was regarded with esteem and respect by all those who knew him.

PETER LOWE, assistant secretary of the Kempsmith Mfg. Co., Milwaukee, Wis., died in Garrett, Ind., on April 13, aged forty-five years. He was born in Adrian, Mich., in 1877, and started his career as a city reporter for a daily newspaper. Later he was employed as chief bookkeeper and teller in a savings bank, and after six years connection with the bank he started to learn the machinist trade with the ultimate object of becoming a machine tool salesman. As a mechanic he was employed by the Port Huron Engine & Thresher Co., the Gisholt Machine Co., and the Nordyke & Marmon Co. While he was working he took a correspondence course in mechanics, and later took up industrial accounting. He entered the employ of the Kempsmith Mfg. Co. in 1906, taking charge of the cost department. During the time that he was in charge of this department he devised many new methods of recording machine shop costs and making time studies. He also had charge of the finished stock, thus gaining a knowledge of the customers' requirements. In 1911 Mr. Lowe entered the sales department, and was a stockholder and assistant secretary at the time of his death. He had retired from active association with the sales department some time previous to his death on account of ill health.

COMING EVENTS

May 8-10—Annual convention of the National Supply and Machinery Dealers' Association in Atlantic City, N. J.; headquarters, Marlborough-Blenheim Hotel. Secretary, Thomas A. Fernley, 505 Arch St., Philadelphia, Pa.

May 8-10—Twenty-seventh annual convention of the National Association of Manufacturers in New York City; headquarters, Waldorf-Astoria Hotel. General offices of the association, 50 Church St., New York City.

May 8-11—Spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga., Assistant Secretary (Meetings), C. E. Davies, 29 W. 39th St., New York City.

May 9—Meeting of the Society of Industrial Engineers in Chicago, Ill. Business Manager, George C. Dent, 327 S. La Salle St., Chicago.

May 10-12—Ninth National Foreign Trade Convention in Philadelphia, Pa. Secretary, O. K. Davis, 1 Hanover Square, New York City.

May 15-20—Seventh annual convention and exhibition of the National Association of Purchasing Agents in Rochester, N. Y. For further information, address S. M. Crosland, care of the Todd Protectograph Co., 1050 University Ave., Rochester, N. Y.

May 18-20—Annual conference of the National Association of Office Managers in Washington, D. C. Secretary, F. L. Rowland, Gilbert & Barker Mfg. Co., Springfield, Mass. Guests are invited to attend.

June 5-9—Annual convention and exhibit of the American Foundrymen's Association and allied societies in Rochester, N. Y. Secretary C. E. Hoyt, Marquette Bldg., 140 S. Dearborn St., Chicago, Ill.

June 14-21—Annual meeting of the Mechanical Division of the American Railway Association in Atlantic City, N. J. Secretary V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill.

June 15-24—International exhibition of foundry equipment and materials in Birmingham, England, in connection with the annual convention of the Institution of British Foundrymen.

June 20-24—Summer meeting of the Society of Automotive Engineers at White Sulphur Springs, W. Va. Chairman of Meetings Committee, C. F. Scott, 29 W. 39th St., New York City.

June 26-July 1—Twenty-fifth annual meeting of the American Society for Testing Materials in Atlantic City, N. J.; headquarters, Chalfonte-Haddon Hall Hotel. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

August 28-September 2—Annual Safety Congress of the National Safety Council in Detroit, Mich Secretary, S. J. Williams, 168 N. Michigan Ave., Chicago, Ill.

December 7-13—National Exposition of Power and Mechanical Engineering at the Grand Central Palace, New York City. Charles F. Roth, manager, Grand Central Palace, 46th St. and Lexington Ave., New York.

The sectional meetings of the American Society of Mechanical Engineers for the month of May are as follows: **May 2**—Cleveland Section at the Cleveland Engineering Society Rooms in Hotel Winton, Cleveland, Ohio; **May 3**—Buffalo Section at Buffalo, N. Y.; **May 4-5**—Mid-continent section, in joint meeting with other national engineering sections and chapters, at Tulsa, Okla. **May 5-6**—Virginia section at Charlottesville, Va.

NEW BOOKS AND PAMPHLETS

Engineers' License Laws. 136 pages, 6 by 9 inches. Compiled by the American Association of Engineers, 63 E. Adams St., Chicago, Ill. Price, 50 cents.

This is a compilation of exact copies of the license laws for professional engineers in various states, and it contains sixteen laws now in force in the United States. It has been prepared and published as a service to the profession, for the use of engineers who desire to practice engineering in more than one state, and also for the assistance of those engaged in the preparation of a law in states where engineers are not registered.

The Public Refuses to Pay. By F. Lauriston Bullard. 89 pages, 5 by 8 inches. Published by the Marshall Jones Co., 212 Summer St., Boston, Mass. Price, 50 cents.

This book contains a reprint of editorials appearing in the Boston Herald on the railroad and building situation. It points out how the public pays the cost of excessive building construction, and how the regulations made by the unions have hampered efficient work in railway shops and affected the public welfare. The book is not issued as propaganda in behalf of any cause, the purpose being merely to render a public service by showing how the public suffers from regulations that restrict production and decrease efficiency.

Handbook on Controllers for Electric Motors. 29 pages, 4 by 6¾ inches. Published by the Electric Power Club, 1017 Olive St., St. Louis, Mo. Price, 25 cents.

This pamphlet contains a simple description of controllers for electric motors, and definitions for the various terms applied in that connection. Words which do not appear in the regular dictionaries are explained in simple language, and the meaning of terms with which all users of electrical apparatus should be familiar is given. In addition, information relative to the use of electric controllers is included. Copies may be obtained from the leading manufacturers of electric power and control apparatus or from the secretary of the Electric Power Club, S. N. Clarkson.

Pulling Together. By John T. Broderick. 141 pages, 5 by 7½ inches. Published by Robson & Adee, Schenectady, N. Y. Price, $1, net.

This book deals with the live subject of human relations in industry. It is dedicated to "employers and employes alike, who help each other and the public to see a soul in industry." The introduction, written by the noted scientist, Dr. Charles P. Steinmetz, gives a brief analysis of present industrial conditions, and points out that thinking people in all walks of life are forced to realize more and more that something must be done to bring about better industrial relations. "The great problem before the industrial world today," says Dr. Steinmetz, "is the problem of conciliation and cooperation." This book tells, in a readable way, how a large corporation tried out the plan of employe representation, with highly satisfactory results.

Cooperative Competition. 56 pages, 8½ by 11 inches. Published by the New York Evening Post, 20 Vesey St., New York City. Price, 25 cents.

The subject treated in this pamphlet is of particular interest at this time in view of the wide discussion of trade associations in the technical and general press, and the recent conference of trade association representatives and editors of the technical press with Secretary Hoover. The pamphlet contains twenty-five articles which have appeared daily in the New York Evening Post, outlining the ideas of business men, lawyers, economists, and government officials concerning the proper and legitimate field of the trade association. The introductory article is by Herbert Hoover. The articles point out the field of usefulness of trade associations, and the pitfalls they must avoid. The purpose of the Post, in publishing these articles, is to support the legitimate activities of trade associations, and to bring before the public more prominently the benefits to be derived by such organizations.

The Design and Construction of Oil Engines. By A. H. Goldingham. 480 pages, 5 by 7½ inches. Published by Spon & Chamberlain, 120 Liberty St., New York City. Price, $4.

The remarkable progress in the oil engine industry during recent years has made necessary a new revised and enlarged edition of this book on the construction of oil engines. The new edition has been brought up to date by the addition of 140 pages of new matter and 72 illustrations. Because of the quantity of material added, the book has been divided into two parts, the first of which deals with modern high-compression two-cycle and four-cycle engines, and the second with historical and earlier types of low-compression oil engines. The descriptions of the older engines have been retained, as this information is of great value where such engines are still in service and is also useful for purposes of comparison. The book contains full directions for testing, installing, operating, and repairing oil engines, and describes different American and European types. It is illustrated with many diagrams, which serve to simplify and clarify the descriptive parts of the text.

Crain's Market Data Book and Directory of Class, Trade, and Technical Publications. 456 pages, 6 by 9 inches. Published by G. D. Crain, Jr., 537 S. Dearborn St., Chicago, Ill. Price, $5.

The 1922 edition of this directory has been completely revised, and new industrial and merchandising data, as well as new lists of publications have been included. All of the most recent government census figures are included in the marketing surveys, and figures on the cost of doing business and turnover are given for all retail merchandising fields. In addition to the list of American publications, a complete list of foreign trade and technical papers is given, which should be especially serviceable to those interested in advertising work abroad. The arrangement is the same as in the previous edition. The basic idea of the book is to present statistical and marketing data regarding each industry, trade, or profession and to give a list of publications serving each field, for the benefit of the advertiser or merchandiser. The publication data includes the principal items which advertisers desire to know about mediums, namely, field covered, publication date, closing date, size of type page, maximum and minimum page rates, circulation, etc. Both the markets and the publications are indexed.

Success through Vocational Guidance. By James McKinney and A. M. Simons. 270 pages, 5½ by 8¼ inches. Published by the American Technical Society, Chicago, Ill. Price, $2.

Occupational analysis has received considerable attention in the industrial world in the last few years, and a book on this subject will doubtless be of interest at the present time. The book under discussion is intended to assist people who are starting out on a business career or those who are dissatisfied with their occupations to choose a life-work for which they are fitted and which they will find congenial. It outlines, in a general way, the qualifications necessary and the education and training required for different branches of work, and gives an idea of the opportunities offered (or the remuneration received). The lines of work covered include professions, engineering, commerce, accounting, advertising, manufacturing, banking, transportation, building trades, hotel and restaurant keeping, mining, forestry, civil service, social service, and agriculture.

NEW CATALOGUES AND CIRCULARS

A. M. Byers Co., Pittsburg, Pa. Pamphlet entitled "Concerning Pipe. By a Piper," containing information on Byers' wrought-iron pipe.

Columbia Mfg. Co., Belleville, Ill. Supplement A to Grinder Book No. 26, giving list prices of the electric buffers and grinders made by this concern.

New Departure Mfg. Co., Bristol, Conn. Loose-leaf circulars 145 and 146 FE, illustrating installations of New Departure ball bearings in motor-driven wood saws and wood shaper spindles.

Northern Engineering Works, 210 Chene St., Detroit, Mich. Crane and hoist booklet No. 24 G, illustrating installations of Northern electric traveling cranes, gantries, and electric hoists.

Simplex Jack Co., Kenly & Co., Ltd., 1020 S. Central Ave., Chicago, Ill. Catalogue of "Simplex" jacks, giving data covering the capacity, dimensions, and prices of the different types and sizes.

Climax Motor Devices Co., Chagrin Falls, Ohio. Circular descriptive of the "Climax" cord disk coupling, which is made in four sizes of 5½, 6½, 7½ and 9 inches diameter, for transmitting any desired power load.

Mercury Mfg. Co., 4118 S. Halsted St., Chicago, Ill. Circular showing illustrations of a "trackless train" installation made by this company in Japan. The installation consists of four Mercury Type L-4 tractors and several Mercury Type A-132 warehouse trailers.

Twentieth Century Brass Works, Belleville, Ill. Circular giving specifications for the line of ice-cooled bubbling fountains made by this concern, which are applicable for use in factories, shops, offices, schools, stores, theaters, and other buildings.

Engineering School of Drawing, 457 Main St., Springfield, Mass. Circular outlining the features of the engineering service offered by this school, which includes the making of tracings, detailing, designing, and the developing of inventions.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 67900, descriptive of Sprague narrow-unit panelboards of the safety type, which have been designed to meet the demand for a safety type panel at a moderate price.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Instruction sheet containing information on the proper care of punches and dies, which is intended to be posted where operators using this class of tools may readily refer to it.

Turbine Air Tool Co., 710 Huron Road, Cleveland, Ohio. Pamphlet entitled "Face the Issue," illustrating and describing a number of production tools, including portable turbine drills and grinders. The weight, capacity, and speed are given for the different sizes.

Chase Metal Works, Waterbury, Conn. Circular entitled "Why Brass Pipe?—Doesn't it Cost More?" containing tables showing weight per lineal foot of seamless brass and copper tubing in plumbers' sizes and iron pipe sizes. The base prices are given for the different sizes.

Chapin-Skelton Corporation, 406 Ash St., Syracuse, N. Y. Catalogue containing tables of dimensions and prices, as well as general descriptive material, covering the line of tools made by this concern, which includes reamers, boring-bars, lathe arbors, counterbores, production tools and special machines.

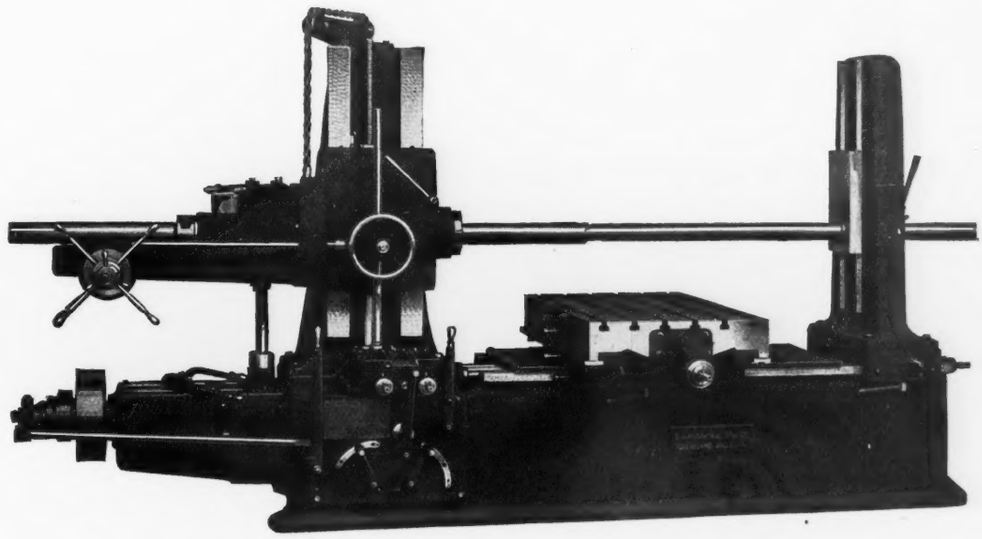
Reynolds Engineering Co., 101 Third Ave., Moline, Ill. Circular illustrating the use of the "Ever-Ready" connecting-rod aligning gage. The advantages of this gage are pointed out, and operating instructions are given. The Blood-Davies Co., 122 S. Michigan Ave., Chicago, Ill., is selling agent for this gage.

Necessity Wrench Shop, 415 Barclay Block, Denver, Col. Pamphlet descriptive of a drop-forged steel wrench, known as the "Necessity" wrench, which is designed for use in places where a double-end tap wrench cannot be employed. Price lists are given for the two different sizes in which this wrench is made.

Monitor Controller Co., Baltimore, Md. Bulletin 102, containing "Thermaload" starter instructions. Directions are given for the installation and care of these starters, and methods of locating and remedying trouble are described. A table of ampere rating of thermal elements to be used with induction motors is included.

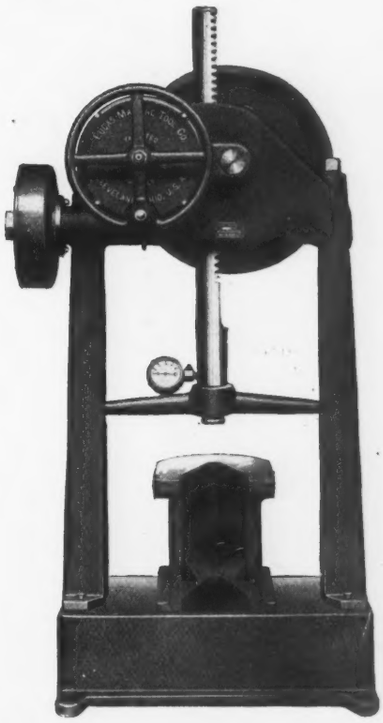
It is sometimes astonishing to discover the obvious. One of our customers was astonished to discover that the job he had always been obliged to send to one of his neighbors who had an open side planer, could easily be done on his new

"Precision" BORING, DRILLING & Milling Machine



There is no more "power" in a Press (or other machine) than is put into it. If the power is put in by hand, it is only one man power. In the

LUCAS Power Forcing Press



the power is put in by belt or motor, but it has all the sensitiveness and delicacy of control of the best hand press, with the necessary power for heavy work.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Company, Turin, Barcelona, Zurich. Benson Brothers, Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Company, Tokyo, Japan.

Golden Co., 405 Lexington Ave., New York City, has issued two bulletins in French, containing a description of RBF ball and roller bearings, and data on the application of these bearings to electrical machinery, hoisting machinery, cranes, etc. The calculation of loads is given, as well as numerous illustrations of bearing applications.

Fairbanks Co., 416 Broome St., New York City. Bulletins illustrating and describing the Lewellen variable-speed transmission, which is made in two types—the self-oiling design and the ball-bearing design. This transmission is made in sizes of from 1 to 150 horsepower, and the sizes carried in stock range from 1 to 25 horsepower, inclusive.

W. S. Rockwell Co., 50 Church St., New York City. Bulletin 241, on forging and heating furnaces, pointing out fundamental principles affecting the quality and cost of forgings, and other formed parts. Illustrations of typical equipment are shown, and descriptions are given of the heating and handling methods employed to meet a wide variety of manufacturing conditions.

Lovejoy Tool Works, 331 W. Ohio St., Chicago, Ill. Catalogue 10, illustrating and giving specifications for the line of tools and machinery made by this company for railways, boiler makers, and steel workers. These tools include ratchet drills, drilling posts, screw punches, ratchet wrenches, "Use-Em-Up" drill sockets, roller expanders, flue cutters, pneumatic hammers, ball-bearing jacks, etc.

Kurtz Equipment Co., 57 Houston St., New York City. Circular 294 of "Hallowell" steel lift truck platforms, which are made with steel runners that flare outward at both ends, so that the truck can slide in between skids without damaging them. Booklet R, outlining the features of construction of "Bond" anti-friction swivel truck casters, which operate in ball bearings to insure easy operation under heavy loads.

Ideal Electric & Mfg. Co., Mansfield, Ohio. Bulletins 102 and 103, containing specifications and illustrations of Ideal direct-current motors and generators, and Ideal squirrel-cage and slip-ring induction motors. The bulletins give ratings and speeds for the different sizes and types of motors included in the standard line, as well as other detailed information relative to the construction and application. Copies will be sent to those interested, upon request.

South Bend Lathe Works, 460 E. Madison St., South Bend, Ind. Circular showing South Bend lathes in use on a variety of operations, including grinding, drilling, turning, boring, threading, and milling. The illustrations give a clear idea of the wide range of work for which these machines are adapted. The circular also illustrates some of the different sizes of South Bend quick-change gear lathes, bench lathes, silent chain motor-driven lathes, and gap lathes.

Uehling Instrument Co., Paterson, N. J. Bulletin 112, containing information relative to Uehling carbon dioxide equipment, which is intended to guide the engineer and fireman in reducing fuel waste. The pamphlet points out the advantages of this equipment, outlines the principles of operation and describes the different units. Particular attention is called to the "Pyro-porus" filter which is a recently developed product designed to keep the gas sampling lines clean.

Kingsbury Machine Works, 4320 Tackawanna St., Frankford, Philadelphia, Pa. Catalogue C, treating of Kingsbury thrust bearings. The book contains data on dimensions, principle of operation, lubrication and cooling, unit pressures, friction losses and wear, results of tests, power loss determinations, and standardization of power losses. The different types of thrust bearings produced by this company are illustrated and described and instructions are given for installing and operating them.

Page Steel & Wire Co., Bridgeport, Conn. Catalogue 500, containing information on Page-Armco welding rods and electrodes for oxy-acetylene and electric welding. A list of the fields in which these products are especially applicable is given, and examples of welding operations are shown. Considerable welding data of general interest are included, as for example, diameter of rods used on various thicknesses of metals to be welded, American Welding Society specifications for electrodes, table of deposited metal for a given thickness of plate, electrical units, etc.

F. J. Littell Machine Co., 4125 Ravenswood Ave., Chicago, Ill. Catalogue covering this company's line of automatic feeds for all makes and sizes of punch presses, including automatic roll feeds, dial feeds, and special feeds. Attention is called to the advantages of automatic feeds, namely increased production and safety. The pamphlet also illustrates a line of special machinery made by this concern, which includes automatic straightening and cutting-off machines, wheel-truing tables, winding heads, and crankshaft and camshaft straightener and tester. Copies will be sent to those interested, upon request.

Jacobs Mfg. Co., Hartford, Conn., has published a reference work known as the "Spindle Book," which is intended for free distribution, particularly among dealers in machine tools and supplies. The book contains spindle specifications of various types of machine tools using either taper-shank drills, taps, or drill chucks. The types of machines included comprise centering machines, drill grinders, flexible shafts, portable electric drills and portable pneumatic drills, tap grinders, tapping machines, drilling machines, bench lathes, and other lathes. The names and addresses of the manufacturers of the various machines and the spindle specifications are given in each case, and an alphabetical list of the manufacturers is given in the back of the book. A chart of arbor holes of Jacobs drill chucks is also included.

Niles-Bement-Pond Co., 111 Broadway, New York City, is issuing a series of pamphlets called the "Progress Reporter," recent numbers of which are especially devoted to railroad requirements. Pamphlet No. 29 deals with roundhouse repair facilities, and contains lists of machine tools required in roundhouse repair shops and terminal dispatching shops. A large number of illustrations of Niles-Bement-Pond machines adapted for this class of service are included. Progress Reporter No. 30 is devoted to modern railroad foundries, and smith and hammer shops. Tables containing lists of machines required in smith and hammer shops and in foundries are given, as well as diagrams showing lay-outs of machine and foundry equipment. This book also contains illustrations of Niles-Bement-Pond foundry and hammer shop equipment.

TRADE NOTES

Whiting Corporation, Harvey, Ill., has moved its Chicago sales office from 1245 Marquette Bldg. to 945 Monadnock Bldg.

Langhaar Ball Bearing Co., Aurora, Ind., is beginning the construction of a new factory, 40 by 150 feet, in Aurora.

Hess-Schenck Co., Cleveland, Ohio, dealer in new and used machinery is now occupying the first floor and basement of its remodeled building at 801 St. Clair Ave.

Monarch Machine Tool Co., 209 Oak St., Sidney, Ohio, is considering installing a sprinkler system in its factory and would like to get in touch with firms making such equipment.

Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., has discontinued its association with the Mayhew Steel Products, Inc., by mutual agreement, and hereafter will handle all sales of the company direct from Bridgeport.

Electric Furnace Co. has moved its general and sales offices from Alliance to Salem, Ohio. By this change all departments of the company will be consolidated at its works at Wilson St. and Pennsylvania Railroad in Salem.

Simmons Machine Co., Inc., Albany, N. Y., manufacturer and dealer in machinery and tools, has opened a machine tool warehouse at 182 Lafayette St., New York City. All the machines displayed in this warehouse will be tools that have been rebuilt in the Albany plant.

Knauel Tool Works have moved from 1544 24½ St. to 210 Fifth Ave., Rock Island, Ill., where they will continue to manufacture calipers and to develop special machinery and tools for inventors. The new quarters will afford the company about four times the previous shop space.

Tool Equipment Sales Co. is a new sales organization formed by Jesse B. Alton and C. B. Cole in Chicago, Ill., at 18 S. Clinton St. The concern will carry complete stocks for the Alvord Reamer & Tool Co., of Millersburg, Pa., and the Standard Saw & Tool Mfg. Co., Inc., of Boston, Mass.

Gits Bros. Mfg. Co., 1940 S. Kilbourn Ave., Chicago, Ill., manufacturer of the Gits oil-cups for machine tools and all kinds of machinery, has just completed an addition to its factory, of 50 by 75 feet, and reports business in its line to be good. This company is bringing out a one-piece oil-cup.

Meldrum-Gabrielson Corporation, Syracuse, N. Y., has constructed a large new factory at West Fayette and Niagara Sts. The factory is completely equipped with machinery for the manufacture of milling machines, adjustable-limit snap gages, and wood and metal patterns. The firm also has facilities for handling contract work.

Ludlum Steel Co. Watervliet, N. Y., announces that the suit brought by the American Stainless Steel Co, of Pittsburg, Pa., alleging infringement by the Ludlum Steel Co. of the Brearley and Haynes stainless steel patents has been dismissed by the United States District Court at New York on the ground that no infringement was shown.

Sandvik Steel, Inc., has consolidated its general steel and steel belt conveyor departments, both of these departments now being located in the Woolworth Bldg., Suite 2001, 280 Broadway, New York City. The officers of the company are as follows: President and general manager, W. D. Thomas; vice-president, Anders Johnson; secretary, Garrick M. Spencer; and sales manager, Harry Carlson.

William K. Stamets, dealer in machine tools, has moved the Cleveland office of the concern to 974-976 Kirby Building. Agency arrangements have recently been concluded with a group of Hartford manufacturers, including Billings & Spencer Co., Hanson-Whitney Machine Co., Hartford Tap & Gauge Co., Taylor & Fenn Co., and the Whitney Mfg. Co. George D. Miller is manager of the Cleveland office.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., was recently awarded a contract for the electrical equipment of a hot strip mill which is to be installed in the plant of the West Leechburg Steel Co., of Leechburg, Pa. The contract includes direct and alternating-current motors, motor-generator sets and control equipment.

Abrasive Co. of Canada, Ltd., Hamilton, Ont., Canada, manufacturer of artificial abrasives, at its annual meeting of stockholders in Philadelphia, Pa., in March re-elected the directors and the following officers: Frederick S. Dickson, chairman of the board of directors; Louis T. Byers, president; J. Harvey Byers, vice-president and general manager; Lawrence J. Morris, vice-president; and Samuel P. Byers, secretary and treasurer.

Driver-Harris Co., Harrison, N. J., has moved the Chicago branch of the company to larger quarters at 562-574 W. Randolph St. For some time the Chicago facilities have been inadequate, and it is believed that with the larger quarters the office will be able to give better all-around service to the various industries using "Nichrome" products.

Ogden R. Adams, Rochester, N. Y. will hold the third annual machinery demonstration given by the concern, at the Adams plant on Central Ave. and St. Paul St., June 2 and 3. This year two days will be given to the demonstration, which will be on a larger and more diversified scale than heretofore. Manufacturers and their technical experts from various parts of the country will be present to demonstrate their products. Other unusual and interesting features will be presented to make the two days helpful and entertaining to all who attend.

Rockford Milling Machine Co., Rockford, Ill., announces that the **Mid-West Machinery Exchange**, of Kansas City, Mo., will handle the complete line of Sundstrand lathes manufactured by the Rockford Tool Co., in the Kansas City territory. **The English Tool & Supply Co.**, of Kansas City, will handle the cone-drive milling machines manufactured by the Rockford Milling Machine Co., and the **Peden Iron & Steel Co.**, of Houston, Texas, will handle Rockford milling machines in the state of Texas. The **Greensboro Supply Co.**, of Greensboro, N. C., has been appointed exclusive agent for Rockford milling machines in North and South Carolina.

Mexican Chamber of Commerce of the United States has been incorporated under the laws of the state of New York, with headquarters in the Woolworth Bldg., New York City. The object of the Chamber will be to promote business and economic relations between Mexico and the United States; to spread general information of reciprocal interest, and to foster friendly feeling. The directorate is composed equally of citizens of both countries who will furnish members with accurate information and assistance in the development of actual business. Offices of the Chamber have also been established in Mexico at 45 Bolivar St., Mexico City.

Rivett Lathe & Grinder Co., Boston, Mass., announces that although the extraordinary business conditions have made it necessary for a receiver to be appointed for the company in order to protect the creditors, safeguard the assets and maintain uninterrupted operation of the plant, the receivership will be of a temporary nature. A financial reorganization plan is being worked out to provide sufficient working capital. Although the company, like many other machine tool builders, lacks working capital, it is not insolvent, as the assets are nearly three times the liabilities, according to actual appraisal. The plant will continue in operation on an increased schedule during the receivership, and the company is in a position to accept and ship orders and to contract for new business.

Air Reduction Sales Co., 342 Madison Ave., New York City, has given out further details concerning the activities of this company and the Davis-Bournonville Co., the amalgamation of which was mentioned in the Trade Notes column of April MACHINERY. The Air Reduction Sales Co. owns and operates nineteen oxygen plants in industrial centers of the country, as well as a large number of plants manufacturing acetylene and other gases, and welding and cutting equipment; in addition, extensive laboratories are maintained for carrying on research work in connection with its various activities. The Davis-Bournonville Co. was organized in 1907 by Augustine Davis, Eugene Bournonville, and C. B. Wortham. At this time Mr. Davis and Mr. Bournonville acquired the rights in the United States and Canada for the Gauthier-Ely oxy-acetylene torch. From that time on, the efforts of the company were directed toward the development and improvement of the original positive-pressure torch. Later its line was extended to include oxy-acetylene cutting torches and acetylene generators, and finally a line of machines for welding and cutting was added. It is the intention of the Air Reduction Sales Co. to continue the manufacture of the Davis-Bournonville products under the supervision of the men who developed these apparatuses. The equipment will be marketed under the trade name of Airco-Davis-Bournonville.